CHAPTER 4: CHINOOK CONSERVATION STRATEGY FOR WRIA 8

Chapter 4: Chinook Conservation Strategy for WRIA 8

The purpose of this chapter is to document the scientific rationale for the conservation actions that will be described in Chapter 5. The Conservation Strategy is a series of hypotheses about how the rehabilitation of WRIA 8's three Chinook populations can be achieved through landscape-level and instream conservation actions. A summary of the Conservation Strategy is included at the end of this section.

It should be noted that while the ecosystem objectives and guiding principles described below call for a multi-species approach, the Conservation Strategy described in this chapter is focused on the viability of Chinook salmon populations in WRIA 8. This Conservation Strategy will be expanded by the Technical Committee to include additional salmonid species when requested by the WRIA 8 Steering Committee.

Ecosystem Objectives

The WRIA 8 Technical Committee (Technical Committee) members relied upon a series of ecosystem objectives and guiding principles to develop and apply the Conservation Strategy. These objectives and guiding principles were originally developed as part of the WRIA 8 Near-Term Action Agenda (available at http://dnr.metrokc.gov/Wrias/8/near-term-action-agenda.htm) and are repeated here, as they constitute the conceptual framework underlying the development of the WRIA 8 Conservation Strategy.

The WRIA 8 Conservation Strategy recognizes four ecosystem objectives for salmon habitat protection and restoration. These ecosystem objectives are the basis for developing and prioritizing habitat actions that are responsive to habitat factors of decline. The objectives are to:

- Maintain, restore, or enhance watershed processes that create habitat characteristics favorable to salmon.
- Maintain or enhance habitat required by salmon during all life stages and maintain functional corridors linking these habitats.
- Maintain a well-dispersed network of high-quality refuge habitats to serve as centers of population expansion.
- Maintain connectivity between high-quality habitats to allow for population expansion into recovered habitat as degraded systems recover.

Guiding Principles

Knowledge of natural watershed processes can provide a design template for the implementation of conservation actions. However, highly altered environments throughout the Lake Washington/Cedar/Sammamish Watershed may require unique approaches that differ from complete restoration of historic natural watershed processes. The following guiding principles characterize what should be done specifically in WRIA 8 to restore the altered environment in a way that is consistent with the ecosystem objectives; the guiding principles also serve to focus the near-term actions on factors of decline.

The WRIA 8 guiding principles are to:

- Protect and restore natural physical, chemical, and biological processes and the habitats they form that are necessary for the recovery and conservation of salmon in the Lake Washington/Cedar/Sammamish Watershed.
- Protect and maintain existing quality refuge habitats from which salmon populations may expand.

- Maintain and restore the corridors that link habitats, including headwaters, channel migration zones, floodplains, wetlands, lake shorelines, estuaries, and marine nearshore habitats.
- Maintain and reconnect salmon access to freshwater, saltwater, and estuarine habitats.
- Emphasize self-sustaining, abundant, diverse, and widely distributed runs of naturally produced salmon when developing protection and restoration strategies.
- Approach the development of management actions in a scientifically rigorous manner, including the articulation of appropriate hypotheses.
- Employ scientifically rigorous adaptive management techniques, including implementation, effectiveness, and validation monitoring, to all elements of conservation activities.
- Identify, protect, and restore those areas that exhibit high existing salmon use, greatest production potential, or a high future conservation value for salmon.
- Plan, develop, and implement management actions (for example, regulations, easements, incentives) to ensure protection of biologically important areas.
- Conduct research and investigations necessary to further the understanding of watershed processes that are critical to the formation of habitat necessary for salmon conservation and survival.
- Identify and implement appropriate action alternatives responsive to habitat-limiting factors and recovery goals for naturally produced salmon.

Finally, the following three additional principles from NOAA Fisheries (Spence et al, 1996) were considered in the development and application of the Conservation Strategy:

- Do no further harm to watershed processes, habitat structure, and aquatic functions important for salmon production.
- Conserve the best remaining habitat that supports Chinook salmon spawning.
- Conserve those areas that are understood to support high Chinook salmon use and productivity, including rearing and migration corridors.

How Are We Using Science to Guide Effective Actions?

As described in Chapter 3, conservation hypotheses concerning the rehabilitation of WRIA 8's Chinook populations were developed using three nested analytical tools to help the Technical Committee answer fundamental questions about Chinook populations, watershed conditions, and instream habitat conditions. The diagram in Figure 4-1 shows WRIA 8's general construct of hypothetical relationships between human activities, watershed processes, instream habitat conditions and salmon population condition. The scientific basis for the relationships described in this diagram, particularly the impacts of human alterations on ecosystem process, structure, and function, are summarized in King County's recent Best Available Science Report (King County 2004; see Volume 1 Chapter 7) as well as Bolton and Shellburg, 2001. Figure 4-2 shows an example of Technical Committee hypotheses about how key habitat conditions influence critical Chinook life stages. The three nested analytical tools used to develop conservation hypotheses about these relationships are as follows:

Viable Salmonid Population (VSP) Framework: What is the status of Chinook populations in WRIA 8, and what are the sources of risk to population viability?

Based on guidance from NOAA Fisheries Puget Sound Technical Review Team, the Technical Committee assessed the status of each Chinook population by looking at four population parameters: productivity, spatial distribution, diversity, and abundance. For each population the relative risk for each population parameter was also assessed to help target conservation actions. The Technical Committee hypothesizes that conservation actions designed to benefit diversity, spatial distribution, and productivity will support increases in abundance. If impacts to population abundance from hatchery influences, harvest, and unfavorable ocean conditions become reduced, local conservation actions will have a proportionately greater effect on population abundance. The Technical Committee recognizes that this hypothesis may not hold where population levels are so low that depensatory (Allee) effects are possible. In such situations actions that directly target abundance will be necessary to rehabilitate the population.

<u>Watershed Evaluation</u>: *Within each of the three populations identified by the WRIA 8 Technical Committee, how should conservation efforts be designed to reflect fish use and the relative watershed conditions in each subarea?*
The watershed evaluation tool was developed to stratify subareas used by each population based on how the subarea is used by Chinook and the relative level of watershed function in the subarea. By combining this information subareas were divided into three Tiers, along with areas used for migration and rearing. Actions in areas of high watershed function should focus on protecting habitat attributes and habitat-forming processes; actions in areas of moderate or low watershed function will require restoration of key habitat attributes and habitat-forming processes. In Tier 3 areas with episodic Chinook use, conservation actions should focus on protecting and enhancing water quality and natural streamflow regimes to benefit other salmonid species and downstream areas used by Chinook. The EDT diagnosis of habitat limiting factors and restoration priorities is available for many of these streams, and the tiering of subareas will be re-evaluated by the Technical Committee to include use by coho and other salmonids as directed by the WRIA 8 Steering Committee. A map showing the independent Chinook populations in WRIA 8 and the subarea Tiers is shown in Figure 4-3. In addition to use of this tool for sub-area stratification and strategy development, the watershed evaluation ratings were used as to corroborate the EDT diagnosis results by comparing watershed conditions with in-stream habitat conditions.

<u>Ecosystem Diagnosis and Treatment (EDT)</u>: *Within each subarea, what habitat conditions should be protected or restored to rehabilitate the population?*
The EDT Model is a riverine habitat model that was customized by the Technical Committee and regional experts to include the nearshore, estuary, Ship Canal and Locks, the Sammamish River, and Lakes Washington, Sammamish, and Union. The EDT model compares the survival of Chinook under current and template (or estimated historic) habitat conditions to 'diagnose' habitat limiting factors and provide a relative sense of the protection or restoration potential of different stream reaches and subareas. At the direction of the Steering Committee, the Technical Committee has not undertaken the 'treatment' step to compare the relative effectiveness of proposed conservation actions. The "treatment" step of EDT will begin early in 2005. The EDT habitat model has been used extensively throughout the Pacific Northwest to support a variety of different salmon conservation efforts, and it is important to remember that the strength of the EDT model (and its stated purpose) is <u>relative</u> comparisons of habitat conditions and salmon performance. The model is not a true salmon population model and is therefore not intended to predict overall salmon population abundance, or the numbers of fish that will benefit from a specific conservation action. However, the PSTRT and co-managers have used EDT as a tool to establish population goals and planning targets based on modeled habitat capacity for eighteen of the twenty-two independent populations in the Puget Sound ESU, but have not done so for WRIA 8.

Additional information about the application of these analytical methods is available in Technical Appendices C-1 (Viable Salmonid Population Framework), C-2 (Watershed Evaluation) and C-3 (Ecosystem Diagnosis and Treatment Habitat Model).

Figure 4-1: Interaction of human activities with riverine/estuarine ecosystem. Human activities influence salmon popu indirectly through influences on biophysical processes and alterations of habitat patterns, and directly through influence population production and diversity. **Adapted from Martin, 1999.**

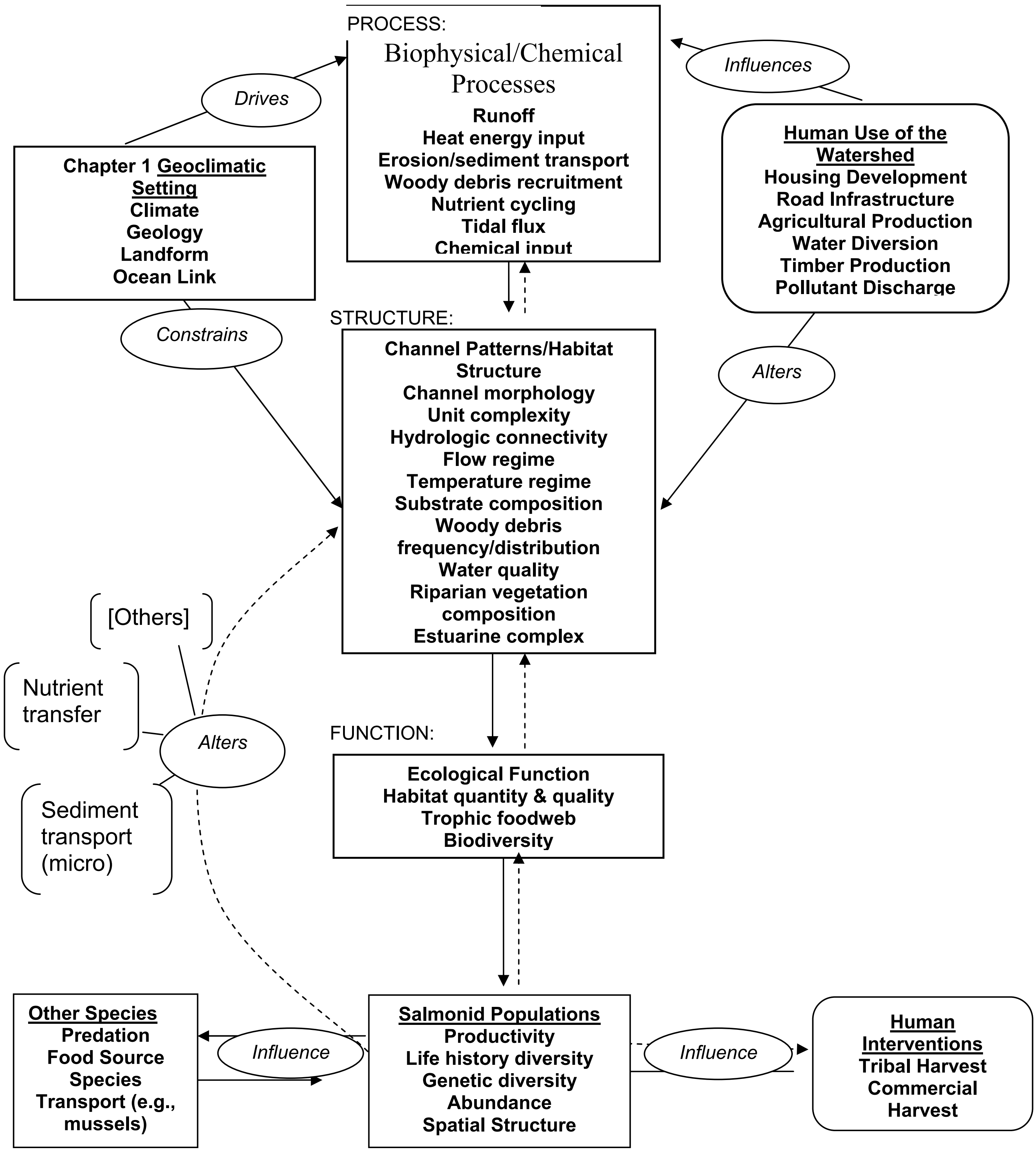
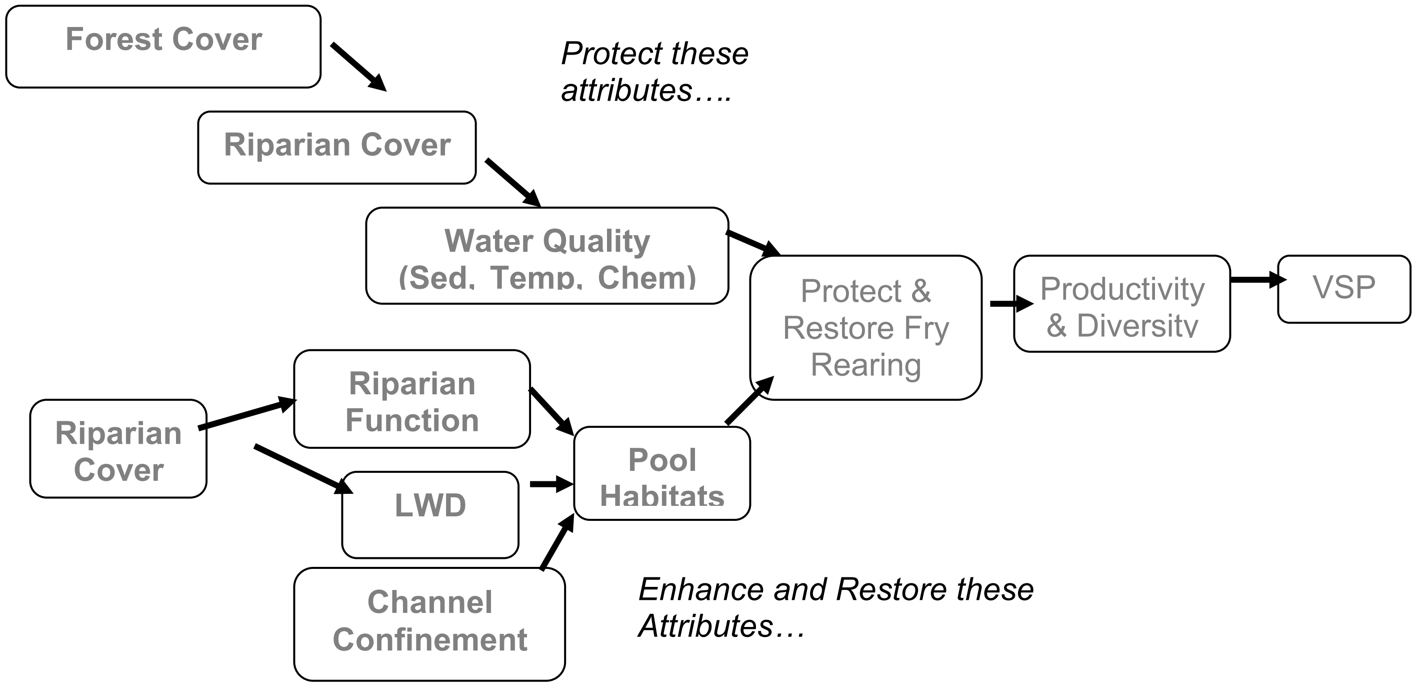


Figure 4-2: Building Conservation Hypotheses Linking Habitat Changes to Population Attributes for Chinook Life Stages (Pre-spawning holding and migration to be added)



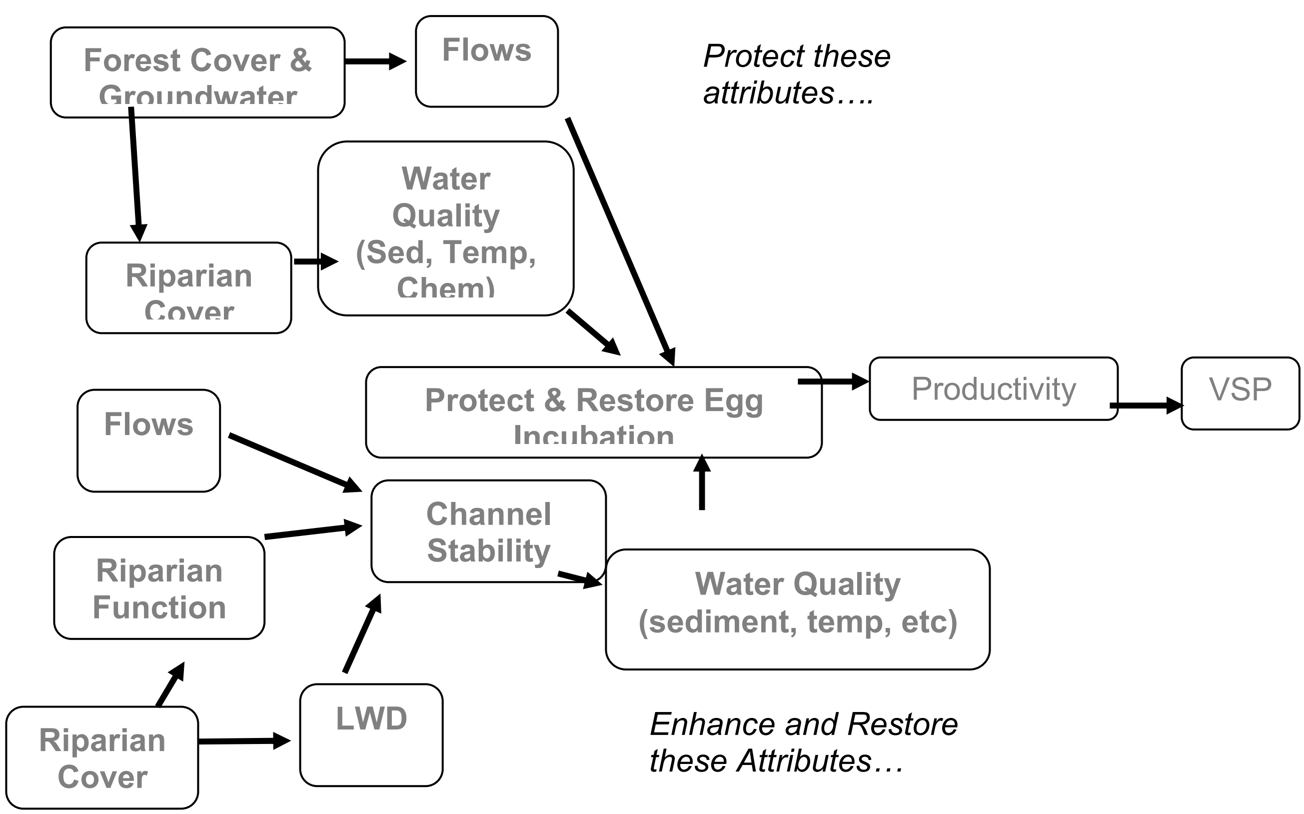


Figure 4-3: INSERT SUBAREA MAP HERE

Viable Salmonid Population Guidance for WRIA 8

The Puget Sound Technical Review Team (PSTRT, 2001) has identified two independent populations of Chinook in WRIA 8: the Cedar River and Sammamish River Chinook. The Sammamish River population includes North Lake Washington and Issaquah sub-populations. In their determination of population structure, the PSTRT notes that it is unclear whether the tributaries draining into the north end of Lake Washington historically supported an independent Chinook population. However, the PSTRT has also identified two factors indicating that this area has the potential to support independent Chinook populations. First, the PSTRT states that the Sammamish River drainage (including Issaquah Creek and the North Lake Washington Tributaries) is larger than the smallest watershed containing an independent population in their analysis of Puget Sound Chinook populations. Second, a recent analysis of spawner capacity developed for the PSTRT by NOAA Fisheries (NOAA Fisheries 2003) indicates that the Bear/Cottage system, the lower portion of North Creek, and Issaquah Creek have a high probability of supporting Chinook spawning, while Swamp Creek, Little Bear Creek, Carey and Holder Creeks, and the upper portion of North Creek have a moderate probability of supporting Chinook spawning.

While two populations are identified in WRIA 8 by the PSTRT, recent genetic information available at the time the Conservation Strategy was developed indicated that there may be enough difference between the North Lake Washington Chinook and fish returning to the Issaquah Creek Hatchery to consider them separate from one another (Marshall 2000). In addition there are other differences such as run timing (e.g., the North Lake Washington Chinook run starts earlier than Issaquah Hatchery returns, peaks at approximately the same time, and tails off over a longer period) that may reflect genetic differences between North Lake Washington and Issaquah Chinook that should be maintained.

After much discussion, the WRIA 8 Technical Committee decided to take a precautionary approach and plan for three populations: the Cedar River population, the North Lake Washington population, and the Issaquah population. The Technical Committee recognizes that the Issaquah and North Lake Washington populations are closely linked, with the Issaquah Hatchery population influencing the North Lake Washington population. The W8TC based their decision to plan for three populations on the desire to adopt a conservative approach to WRIA 8 Chinook populations in light of uncertainties about population structure, and the potential that unique genetic characteristics necessary for the long-term viability of the Issaquah and North Lake Washington populations, if lost, may not be recovered. By identifying three populations, the WRIA placed priority on protecting all Chinook within the watershed, as well as any local adaptations that these fish possess. This approach supports the continued survival of offspring of naturally spawning Issaquah Hatchery Chinook strays which would be protected under the Endangered Species Act. In addition, the three population approach errs on the side of caution to maintain future opportunities for conservation in the Issaquah sub-area. Finally, this approach confers ancillary benefits on other species such as coho, and supports the widest level of stakeholder participation, all of which are consistent with the Steering Committee's stated goals and objectives. Throughout this document, three populations will be discussed, consistent with the direction that WRIA 8 chose to take with Chinook recovery. <u>The reader should note that the use of the term 'population' as it relates to Chinook throughout this document reflects the WRIA 8 Technical Committee's precautionary approach, and that the term is therefore NOT synonymous with the PSTRT's use of the term</u>.

The discussions surrounding WRIA 8 population structure are continuing as new information materializes. In 2003, returning adult hatchery Chinook were adipose-clipped for the first time. Stray rates in that year indicated that there were more hatchery-origin fish on the spawning grounds than expected (22% of spawners in the Cedar River mainstem, 54% of spawners in Bear/Cottage Creeks, and 48% of all spawners in the WRIA). While straying is a natural phenomenon, the large releases of hatchery fish (e.g. 2 million Chinook fry are released annually from the Issaquah hatchery) combined with small populations of naturally-spawning Chinook in WRIA 8 (average adult returns to the Cedar River, for example, was only 325 fish between 1998 and 2002) mean that the relatively high contribution rates of hatchery-origin fish could pose a risk to the genetic diversity of the Cedar and North Lake Washington populations.

The WRIA 8 Technical Committee has initiated a genetic study with Washington Department of Fish and Wildlife (WDFW) to analyze juvenile samples taken from the three assumed populations in WRIA 8, samples from hatcheries known to contribute to adult returns (e.g., University of Washington, Issaquah, Grover's Creek), as well as archived scale and tissue samples from adult spawners. It is expected that this study will help address a number of uncertainties surrounding current genetic differences that exist among wild and hatchery Chinook stocks in WRIA 8. However, it is likely that there will be continued questions regarding the interactions of hatchery and wild Chinook. The WRIA 8 Technical Committee and participating scientists plan to review the genetic study and provide the information to the PSTRT for consideration in identifying independent populations within WRIA 8. The Technical Committee will then adapt the Conservation Strategy in light of this new information. Potential revisions to the Conservation Strategy are summarized in this Chapter and in Appendix C-5.

The risk of extinction posed to all three populations is extreme and must be reduced through actions that create habitat conditions that support viability of the populations. This section will provide conservation hypotheses for all three populations. However, the potential interactions between these populations and the need for additional information about population genetics lead to the following technical hypotheses that should guide conservation actions across the WRIA:

1. The Cedar and NLW populations are both in crisis with an extreme risk of extinction. However, there is some uncertainty that the NLW and Issaquah populations are independent of one another, while there is higher certainty that the Cedar population is independent. The Technical Committee hypothesizes that a higher priority should be placed on risk reduction for the Cedar population due to the steeply declining trends in returning adults and the greater genetic separation from other Chinook in the watershed.

2. Based on 2003 Chinook surveys in WRIA 8 (the first year that clipped hatchery fish were observed in large numbers in WRIA 8), straying of in-basin and out-of-basin produced Green-River origin hatchery (Issaquah, Portage Bay and Grovers Creek Hatcheries)[1] Chinook poses a potential risk to the genetic integrity of any independent Chinook populations. While this risk is primarily due to hatchery produced Chinook, habitat actions to increase the abundance and productivity of naturally spawning Green-River origin Chinook in the Issaquah basin could also unintentionally increase the total number of Chinook straying into the North Lake Washington and Cedar basins, resulting in decreased genetic diversity of the locally adapted populations. In addition to the potential risk to genetic diversity, hatchery straying could pose a risk if hatchery contributions to natural spawning are reducing the fitness or reproductive success of naturally spawning Chinook in WRIA 8. Based on research about the influence of hatchery produced salmon on naturally spawning populations in other systems, (see, for

example, Myers et al 2004 and NOAA Fisheries 2004), the Technical Committee hypothesizes that restoration actions designed to increase productivity and abundance in the Green-River origin Issaquah Chinook population may contribute to the overall extinction risk facing the Cedar and North Lake Washington locally adapted populations. Additional research is necessary to increase our understanding of hatchery contributions to natural spawning, and the impacts of interactions between naturally spawning and hatchery origin Chinook in WRIA 8 on population viability.

WRIA 8 is currently working with the WDFW genetics laboratory to improve our understanding of the genetic variation of Chinook from WRIA 8 streams and several Central Puget Sound hatcheries (including the Issaquah, Grovers Creek, and University of Washington hatcheries), and will review the results of this analysis with the Puget Sound Technical Recovery Team and the Co-Managers in February 2005 to inform their decisions about Chinook population structure in WRIA 8, and WRIA 8's decisions about the future direction of the WRIA 8 Chinook Conservation Plan. Until additional questions are answered regarding existing genetic diversity, hatchery straying, the relative contribution of hatchery strays on the spawning grounds, and the level of genetic introgression that has resulted over time from hatchery contributions to spawning, the Technical Committee advises a precautionary approach that protects and maintains habitat diversity and Chinook genetic diversity within the WRIA.

3. The Issaquah basin includes high quality habitat and geomorphic conditions that contribute to habitat diversity within WRIA 8, and the basin is used by naturally spawning Chinook that are protected under the Endangered Species Act. Protection of existing high-quality habitat in the Issaquah system should continue while the genetic impact of hatchery straying is evaluated.

4. Recent preliminary modeling work by the Hatchery Scientific Review Group (HSRG) (Lakey, 2004) in cooperation with the co-managers indicates that abundance numbers from the WRIA 8 populations are critically low and that WRIA 8 populations may be dependent on hatchery strays unless habitat productivity is substantially increased. Hatchery augmentation of the naturally spawning Chinook in WRIA 8 may be necessary to reduce the risk of extinction while habitat improvements identified in Chapter 5 of this plan are implemented.

The following section describes conservation strategies for each of the three populations described by the WRIA 8 Technical Committee and based on the Technical Committee's analysis of VSP status, the watershed evaluation, and the EDT habitat model.

Conservation Strategy for Cedar River Chinook

The Cedar River is the largest tributary to Lake Washington and drains an elongated basin of 188 square miles that extends from the crest of the Cascade Mountains to the southern shore of Lake Washington in the City of Renton. As described in Chapter 3, the Cedar River was re-routed from the Black River to Lake Washington in 1916. The upper two-thirds of the subarea is owned and managed by the City of Seattle and supplies drinking water to two-thirds of Seattle and its regional customers. The Cedar River Municipal Watershed is almost entirely coniferous forest, and its management is governed by the Cedar River Watershed Habitat Conservation Plan. The lower third of the Cedar River subarea below the Landsburg Diversion Dam includes 21 miles of mainstem river and 15 tributaries, and drains a 66-square-mile area. The lower Cedar River mainstem and four main fish-bearing tributaries provide the majority of the current spawning habitat for chinook and sockeye salmon and steelhead trout in the WRIA 8 system as well as significant spawning and rearing habitat for coho salmon and cutthroat trout. The four main tributaries for Chinook are: Lower Rock Creek, Walsh Lake Diversion, Peterson Creek, and Taylor Creek. Most of the lower Cedar River subarea is rural and forested, except for the cities of Renton and Maple Valley, where the subarea is urbanized.

Results of Technical Analyses

VSP Status and Relative Risk for Cedar River Chinook

For the WRIA 8 Cedar River Chinook population, the assessment of the VSP population parameters can be summarized as follows:

Productivity: Reduced by habitat degradation.
Diversity: Instream juvenile rearing life history trajectory reduced by habitat loss.
Spatial Structure: Historically, it is likely that Chinook were distributed predominately along the mainstem Cedar, with tributaries playing a relatively minor role in terms of overall abundance. The spatial distribution of the population is largely longitudinal along the length of the mainstem Cedar River.
Abundance: As shown in Chapter 3, the population abundance is in steep decline, driven primarily by reduction in habitat productivity and the loss of life history diversity. Hatchery strays are assumed to contribute to the current observed abundance. Low abundance, combined with the downward trend in abundance suggest that the Cedar population is at risk from depensatory (Allee) effects, and therefore at risk of extinction.

At this time none of the four VSP attributes is sufficient to support viability of the population. Rehabilitation of all population attributes will be necessary to restore the population. The relative risk posed to each of the four population attributes is:

- Productivity: High
- Diversity: High due to the combination of hatchery strays that contribute to natural spawning, and reductions in the instream rearing life history trajectory. According to the Hatchery Science Review Group (HSRG, 2004), hatchery contribution rates higher than 1-5 percent would result in a high risk to naturally spawning Chinook from a Segregated Hatchery Program. However, it should be noted that the Co-Managers, in response to the HSRG's recommendations, have recommended that the Issaquah Creek Hatchery Program should be switched from a Segregated to an Integrated Hatchery Program (Lakey, 2004). If an integrated hatchery program is pursued, hatchery contribution rates to natural spawning could be as high as 30 percent with a low risk to the naturally spawning population.
- Spatial Structure: Low
- Abundance: High.

The Technical Committee suggests the following hypotheses based on this assessment of population attributes and relative risk:

- All population attributes require rehabilitation if the Cedar River Chinook population is to be viable.
- Of the four population attributes, the greatest extinction risk comes from reduction in habitat productivity and the potential loss of the instream juvenile rearing life history strategy.

Watershed Evaluation Framework for the Cedar River
Following the assessment of Cedar River Chinook salmon population attributes, the Technical Committee stratified subareas used by the population based on the degree of fish use and the level of watershed function. Using Chinook salmon demographic information to assess the relative abundance within subareas and the frequency that subareas are used by Chinook, the Cedar subareas can be organized as follows:

- Migratory and rearing areas – Lakes Washington and Union, Ship Canal, Nearshore and Estuary.
- Core areas of high Chinook abundance and frequent use – Cedar Middle (Reaches 12-18), Cedar Lower (Reaches 1-11)
- Satellite areas of moderate Chinook abundance and moderately frequent use – Upper Cedar (Reaches 19-28), Taylor / Downs Creek, Walsh Lake Diversion.
- Episodic areas with infrequent Chinook use – Lower Rock, Peterson, Madsen, Molasses.

The relative watershed function of these subareas can then be assessed by rating factors that sustain function and factors that limit function:

- Factors sustaining watershed function: wetland area, forest cover, riparian cover, gradient less than 2%.
- Factors limiting watershed function: Impervious surface, flow volume, road crossings, gradient >4%.

Following an assessment of watershed function factors listed above, the subareas that contribute to the Cedar River Chinook population can be organized as follows:

- High Function – Middle Cedar (Reaches 12-18), Rock Creek, Upper Cedar, Walsh Lake Diversion, Taylor / Downs Creek, Peterson Creek.
- Moderate Function – Lower Cedar (Reaches 1-11).
- Low Function – Madsen Creek, Molasses Creek, Lakes Washington and Union, Ship Canal, Nearshore and Estuary.

By combining the fish use and watershed function ratings, the Technical Committee has stratified the subareas that contribute to the Cedar River Chinook population as follows:

- Tier 1 - Middle Cedar (Reaches 12-18), Lower Cedar (Reaches 1-11), Migratory Areas (Lakes Washington and Union, Ship Canal, Nearshore and Estuary).
- Tier 2 – Lower Rock Creek, Upper Cedar, Peterson Creek, Walsh Lake Diversion, Taylor / Downs Creek.
- Tier 3 - Madsen Creek, Molasses Creek.

The Technical Committee suggests the following hypotheses based on the Watershed Evaluation Framework:

- Protection and restoration actions will be necessary in both Tier 1 and Tier 2 areas to rehabilitate Cedar River Chinook productivity, diversity, spatial distribution, and abundance.
- Watershed function can be improved by improving watershed conditions that limit function (i.e. total impervious area and road crossings) and enhancing factors that sustain function (i.e. total forest cover and riparian forest cover).

- Actions in areas of high watershed function should focus on protecting habitat attributes and habitat-forming processes; actions in areas of moderate or low watershed function will also require restoration or enhancement of key habitat attributes and habitat-forming processes
- Actions in the Tier 3 subareas should focus on protecting and enhancing water quality and hydrologic integrity.

EDT Habitat Model Results and Recommendations for the Cedar River
The results of the EDT diagnosis for each subarea, and the protection and restoration hypotheses developed based on the application of VSP, the Watershed Evaluation Framework, and EDT, are summarized in the following section. Maps showing the EDT reaches are available on the WRIA 8 website (http://dnr.metrokc.gov/Wrias/8/index.htm).

Habitat Protection and Restoration Hypotheses in the Cedar Chinook Tier 1 Subareas

The Tier 1 subareas include Cedar Middle (EDT Reaches 12-18) and Cedar Lower (EDT Reaches 1-11). Each of these subareas is a core area for Chinook use. Cedar Middle has a relatively high level of watershed function resulting from a low impervious surface percentage, few road crossings, and a high level of forest cover and riparian forest. The Lower Cedar has a moderate level of watershed function, due primarily to increases in impervious surface and storm flow volumes, along with reductions in forest cover and riparian cover.

Habitat Protection Hypotheses for the Cedar Chinook Tier 1 Subareas
Recommendations for these subareas focus on protection of the habitat processes and structures that make these areas a significant source of production for the Cedar River Chinook population. Using the EDT habitat model, the Technical Committee hypothesizes that in both the Lower and Middle Cedar Tier 1 subareas the life stages most affected by existing high-quality habitat conditions are egg incubation, fry colonization and pre-spawning migrants. These critical life stages are sustained by protection of the following habitat attributes:

- Water quality (sediments, temperature, metals)
- Flows (sufficient flows during seasonal low flow periods)
- Habitat quantity (pool habitats)
- Habitat attributes that contribute to the creation of pool habitats (riparian function, LWD, channel connectivity).

By comparing the survival of Chinook life stages under existing conditions and fully degraded habitat conditions, the EDT habitat model 'diagnoses' the potential of stream reaches for protection. This potential results from instream habitats, basin-wide conditions that create and maintain that habitat, and Chinook use of habitat in the reach. The Technical Committee has used the watershed evaluation and EDT to prepare protection recommendations for the entire subarea (Table 4-1) as well as individual stream reaches (Table 4-2).

Table 4-1: Basin-Wide Protection Recommendations for Tier 1 Subareas (Cedar Middle Reaches 12-18, Cedar Lower Reaches 1-11)
• Protect water quality to prevent adverse impacts to key life stages from fine sediments, metals (both in sediments and in water), and high temperatures. Adverse impacts from road runoff (especially the Maple Valley Highway SR 169) should be prevented. • Forest cover should be protected throughout each of the subareas to maintain

watershed function and hydrologic integrity (especially maintenance of sufficient baseflows), and protect water quality.
- Road crossings should be minimized to maintain floodplain connectivity
- Provide adequate stream flow to allow upstream migration and spawning by establishing instream flow levels, enforcing water right compliance, and providing for hydrologic continuity. For more information about current flow management of the Cedar River, see Chapter 3.

Table 4-2: Cedar Tier 1 Reach-Level Protection Recommendations (Middle Cedar and Lower Cedar)
Reaches are listed in order of Relative Protection Priority

Tier 1 Subarea:	*Critical Chinook Life Stages for Protection:*	*LWD, Riparian Function, and Channel Connectivity should be protected in the following reaches:*
Middle Cedar (Reaches 12-18)	Pre-Spawning Migrant; Fry Colonization	16, (tie 17 & 18), 15, 14, 12, 13
Lower Cedar (1-11)	Pre-Spawning Migrant; Fry Colonization	4, 8, 9, 3, (tie 5 & 6 & 11), 7, 10, 1, 2

Reach Protection Priorities:
- The landslide reach (Reach 4) has the highest protection potential on the Cedar River. Channel connectivity, LWD, pool habitats, and riparian function should be maintained within this reach to support the potential identified by EDT and to serve as a reference site for habitat restoration efforts in other parts of the Cedar River.
- In the Lower Cedar, pool habitats, LWD and channel connectivity in reaches adjacent to Reach 4 should be maintained to support the potential that exists in these reaches.
- In the Lower Cedar, riparian function, LWD, and channel connectivity should be maintained in reaches with relatively higher use for spawning and egg incubation in the Lower Cedar subarea (Reaches 8-9).
- In the Middle Cedar, riparian function, LWD, and channel connectivity should be maintained in reaches with higher use for spawning and egg incubation (Reaches 14-16)
- In the Middle Cedar, reaches with the relatively most intact riparian function, LWD, and channel connectivity should be maintained. In addition, these features should be protected in downstream reaches 14 and 15 to maintain spawning and egg incubation habitat functions.

Based on the three analytical tools described above, the Technical Committee hypothesizes that conservation actions based on the basin-wide and reach-specific protection recommendations will maintain habitat conditions that are currently favorable to critical Chinook life stages. The Technical Committee hypothesizes that actions based on these recommendations will maintain favorable conditions for these life stages in each of the Tier 1 subareas (Cedar Middle and Cedar Lower) and will ultimately support the existing sources of productivity and life history diversity for the Cedar River Chinook population.

Habitat Restoration Hypotheses for the Cedar Chinook Tier 1 Subareas
Although protection of existing high-quality habitat and habitat-forming processes is the primary objective in the Tier 1 subareas, restoration of watershed function and instream habitat attributes is necessary to the rehabilitation of Cedar Chinook productivity and life history diversity. Based on the EDT habitat model, the Technical Committee hypothesizes that the life stages most affected by degraded habitat conditions in these reaches are fry colonization and pre-spawning migrants. These critical life stages are limited by degradation of the following habitat attributes:

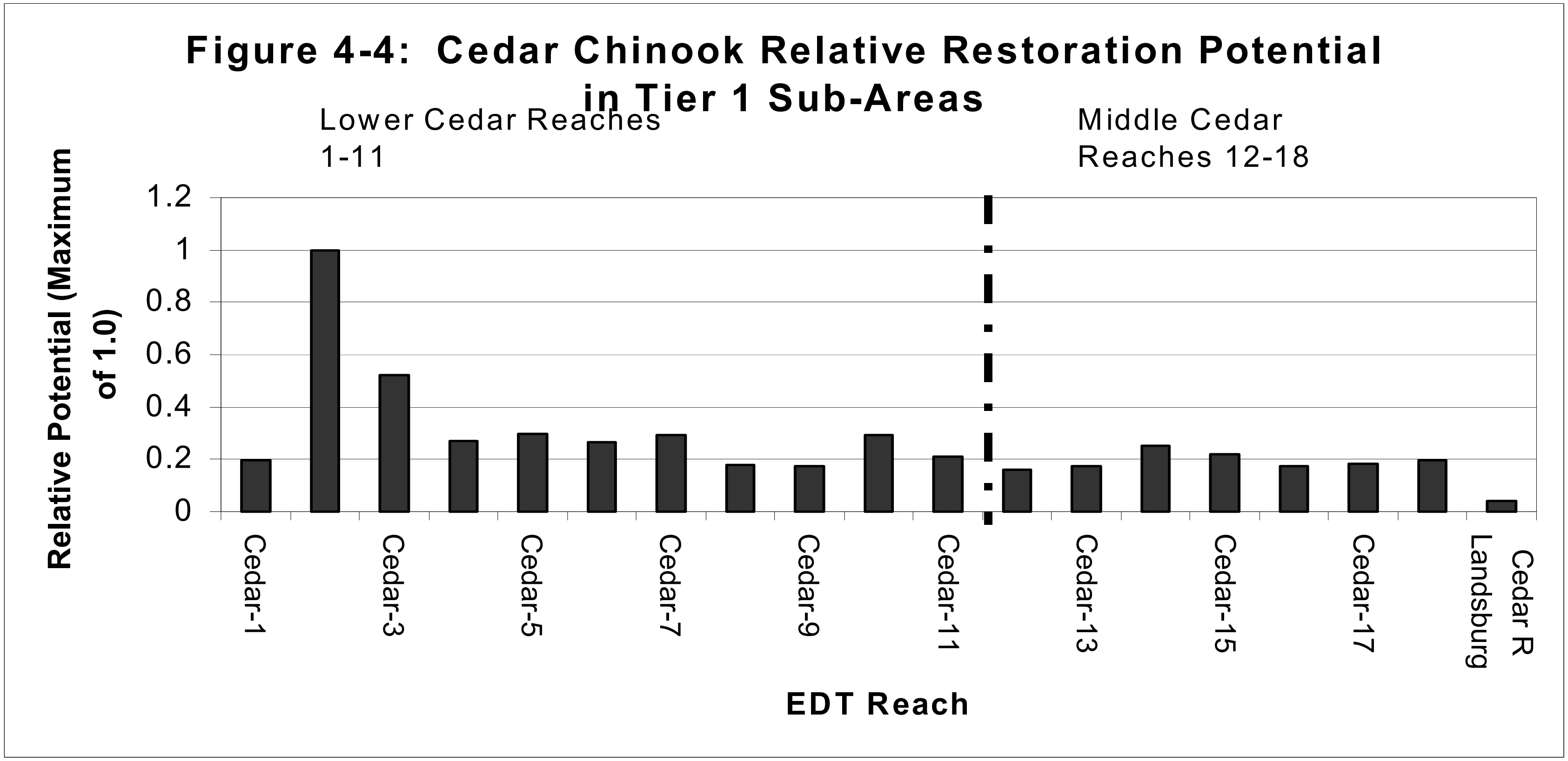
- Habitat quantity (pool habitat area),
- Habitat quality (composed of channel confinement, riparian function, and large woody debris).

By comparing the survival of Chinook life stages under existing conditions and fully restored habitat conditions, the EDT habitat model 'diagnoses' the potential of stream reaches for habitat restoration. The restoration potential of reaches in the Tier 1 subareas is shown in Figure 4-4. This potential results from instream habitats, basin-wide conditions that create and maintain that habitat, and Chinook use of habitat in the reach. For this reason the Technical Committee has used the watershed evaluation and EDT to prepare technical recommendations for the entire subarea as well as individual stream reaches. These recommendations are summarized in Table 4-3. The recommended changes to habitat attributes at the reach and basin scale are intended to create habitat conditions more favorable to critical Chinook life stages. The Technical Committee hypothesizes that improved conditions for these life stages will ultimately increase the productivity, spatial distribution, and life history diversity of the Cedar River Chinook population.

Table 4-3: Cedar Chinook Tier 1 Restoration Recommendations (Cedar Middle and Cedar Lower)

Basin-Wide Recommendations
- Restore riparian vegetation to provide sources of LWD that can contribute to the creation of pool habitat.

Reach-Specific Recommendations
- Channel confinement has reduced floodplain connectivity and reduced the amount of pools and small cobbles. Reach-level restoration actions should focus on setback or removal of dikes and levees, the addition of LWD to create pools, and planting riparian vegetation.
- In the long-term, potential LWD source areas upstream should be restored.



NOTE: The EDT habitat model determines the relative potential of a reach for salmon performance (a combination of productivity, abundance, and life history diversity) based on habitat conditions in the stream reach and the exposure of Chinook life stages to those habitat conditions. Similar habitat conditions may therefore result in different potentials due to differences in Chinook exposure. In addition, the salmon performance potential that exists in a reach may be due to upstream conditions (i.e. hydrologic conditions or sources of sediments and LWD) as well as conditions in the reach. For more information about habitat conditions, key life stages, and technical recommendations, please see the description of each subarea in the Conservation Strategy.

Restoration of Migratory and Rearing Areas for Cedar River Chinook
While restoration of the Tier 1 Cedar River subareas is critical to rehabilitate the productivity and life history diversity of the Cedar River Chinook population, the population is also impacted by conditions in other subareas used for migration and rearing. Based on the Watershed Evaluation and the EDT diagnosis of restoration potential, restoration of Lake Washington should also be a high priority for regional restoration efforts. The EDT results provide a relative sense of the restoration potential in Lake Washington versus the Cedar River, with the potential restoration benefits in the south end of the Lake approximately equal to the potential benefits that exist in the mainstem of the Cedar River below Landsburg Dam.

Based on the EDT diagnosis, juvenile migrants from the Cedar River would benefit from habitat restoration actions that reduce predator abundance and predator efficiency (particularly cutthroats, sculpin, and bass) in Lake Washington. Predation on juvenile Chinook appears to be driven primarily by habitat conditions that limit cover for juvenile Chinook migration and rearing, and increase exposure to predators, such as bank hardening and reductions in sandy shallow water habitat, LWD and overhanging shoreline vegetation. Although the Lake Washington shoreline is highly developed, the remaining areas with these characteristics (sandy shallow-water habitat, overhanging vegetation, LWD) should be protected and maintained.

It should be noted that there is considerable uncertainty about how Chinook use lake habitat in WRIA 8 and how Chinook interact with other species (i.e. sockeye, cutthroat, bass, and perch), and that these uncertainties are the subject of multiple ongoing studies. In light of these uncertainties the Technical Committee strongly recommends that conservation actions in the lakes focus on habitat and landscape solutions that benefit Chinook rearing and migration rather than attempting to manage individual predator species.

The estuary and marine nearshore areas of WRIA 8 are important for the success of Chinook from WRIA 8, as well as juvenile Chinook and other salmonids from other watersheds in Puget Sound. Because of uncertainties regarding how WRIA 8 Chinook use the nearshore and estuary, as well as the documented use of the WRIA 8 estuary and nearshore by Chinook from other WRIAs, the Technical Committee did not rely on the relative geographic priorities produced by habitat modeling efforts. Using the comparison of historic versus current habitat conditions in the Tidal Habitat Model, the Technical Committee concluded that protection and restoration should focus on reversing the effects of anthropogenic modifications to the system, especially the modification of ecosystem processes such as sediment supply, and protecting remaining areas of functioning habitat. However, actions in the estuary are somewhat difficult to assess due to the altered conditions that exist there (i.e. the construction of the Ship Canal and Ballard Locks and the abrupt transition from freshwater to saltwater). In addition, research in the marine nearshore environment has been advancing new concepts and theories in more recent years. It will be important to take an experimental approach to protection and restoration and stay current with emerging information so that restoration and protection actions can be tailored accordingly.

Restoration actions for migratory and rearing areas are summarized in Table 4-4.

Table 4-4: Restoration Recommendations for Cedar River Chinook Migratory and Rearing Areas

Lake Washington:

- Reduce bank hardening by replacing bulkheads and rip-rap with sandy beaches with gentle slopes designed to maximize littoral areas with a depth of less than 1 meter.
- Reconnect and enhance small creek mouths as juvenile rearing areas. Historically these small creeks had sandy deltas at the creek mouth and were associated with wetland complexes.
- Restoration efforts should begin with lake segments at the southern end of the lake, near the mouth of the Cedar River, along with other high priority reaches along the southern shore of Mercer Island and in Union Bay at the entrance to the Ship Canal.
- Protect and restore water quality in small tributaries.
- More information is needed about the trajectories of Cedar River juvenile Chinook in Lake Washington, particularly when they move offshore.
- Shoreline processes of Lake Washington have been changed by the regulated maximum one foot rise and fall of the lake. Therefore, the removal of bank hardening structures may not be sufficient to create sandy beaches and augmentation of sediment supplies may be necessary.
- The outmigration of juvenile Chinook would benefit from improved shoreline connectivity. The use of mesh dock surfaces and/or community docks would reduce the severity of predation on juvenile Chinook.
- Habitat in the smaller Lake Washington tributaries (Tier 3 streams such as Thornton, McAleer, and Lyon) should be restored for coho so that production of cutthroat trout which prey on juvenile Chinook in Lake Washington is reduced.
- Consider increases in fishing limits for cutthroat trout.

Ship Canal and Locks:

- High water temperatures impede juvenile Chinook outmigration during the summer in the Ship Canal. These high temperatures also lead to increased activity by predators (primarily bass). Options to reduce water temperatures in the Ship Canal should be evaluated.
- Protect and restore water quality to prevent adverse impacts to key life stages from fine sediments, metals (both in sediments and in water), and other toxics. In particular, adverse water quality impacts from commercial and industrial land uses should be prevented.
- Additional investigations are needed to determine habitat characteristics that could provide Chinook with refuge from predators in the Ship Canal.
- Riparian vegetation should be restored to provide cover for juvenile migrants.

Table 4-4 (continued): Restoration Recommendations for Cedar River Chinook Migratory and Rearing Areas

Estuary and Nearshore:

- Protect remaining feeder bluff(s) that supply sediment and support littoral habitat creation.
- Reduce bank hardening, especially in areas where the armoring falls within the tidal zone and/or separates a sediment source from the nearshore environment. Such actions would help restore natural shoreline accretion and depletion processes and support littoral habitat creation.
- Undertake a sediment source study to attempt to do 2 things. 1)establish where feeder bluffs were prior to the railroad. 2) quantify rates of erosion of those bluffs. Based on the sediment source study, work with the known locations of feeder bluffs to either open up certain slide prone areas so that slides make it into the nearshore, or start a beach nourishment program. Although all actions discussed in the Conservation Plan will be part of an Adaptive Management program, it should be emphasized that the experimental nature of a beach nourishment program require a comprehensive and robust adaptive management and monitoring system.
- Protect remaining Marine Riparian Vegetation (MRV), to maintain overhanging cover and terrestrial inputs (e.g. leaf litter, invertebrates) for juvenile Chinook and their prey. One example of intact MRV is an area near West Point on an eroding bluff.
- Plant vegetation along shoreline, close to the Mean High High Water (MHHW) line to provide overhanging cover and terrestrial inputs (e.g. leaf litter, invertebrates) for juvenile Chinook and their prey.
- Reduce the number and coverage of overwater structures (e.g., docks, piers) as a way to reduce segmentation of the shoreline and the effects on both habitat forming processes and juvenile Chinook behavior.
- Reconnect and enhance the mouths of small streams to create pocket estuaries. These areas are important for smaller juvenile Chinook and could be very important for juveniles from other watersheds that leave the rivers as fry. For WRIA 8 fish, pocket estuaries may have the most benefit near the Locks by providing an increased estuary area.
- Reconnect backshore areas (e.g., marshes, wetlands) to contribute to shoreline habitat diversity and terrestrial inputs.
- Protection of sediment and water quality, especially near commercial and industrial areas (e.g., fuel spills, discharge of pollutants, etc.).
- More information is needed about how the railroad design could be altered to re-connect nearshore processes such as sediment supplies from feeder bluffs, and restore access to pocket estuaries and backshore areas.
- More information is needed about marine nearshore habitat processes and connections to juvenile Chinook salmon habitat.
- More information is needed about the migratory and rearing behavior of wild and hatchery juvenile Chinook from WRIA 8 in the vicinity of the Locks and WRIA 8 nearshore. Increased use of coded-wire tags (CWT) would improve our understanding of how salmonids from WRIA 8 and other Puget Sound WRIAs use the nearshore environment.
- More information is needed to evaluate the affects of hatchery outputs (both timing and amounts) on survival and growth of wild salmonids in the marine nearshore.
- More information is needed about how commercial and recreational crab harvest affects the available prey resources for juvenile Chinook.

Habitat Protection and Restoration Hypotheses in the Cedar Chinook Tier 2 Subareas

The Tier 2 subareas for the Cedar River Chinook population include the Upper Cedar (above Landsburg), Lower Rock Creek, Taylor/Downs Creek, Peterson Creek, and Walsh Lake Diversion. Full passage at Landsburg Dam was assumed as part of the EDT habitat modeling exercise in order to determine the protection and restoration potential in these reaches. .At this time the Technical Committee has prepared recommendations for the Upper Cedar, Lower Rock, Peterson, and Taylor/Downs Creek. Recommendations for Walsh Lake Ditch have not been developed while the potential re-direction of the Walsh Lake Diversion back into Upper Rock Creek (a Cedar River tributary above Landsburg Dam that is separate from Lower Rock Creek) is being evaluated. If directed by the Steering Committee, the 'Treatment' phase of the EDT model may be used as part of feasibility studies and evaluations conducted to support decisions on this issue.

All of these Tier 2 Cedar subareas are considered to be satellite areas for the Cedar River Chinook population. As noted in the VSP analysis of the Cedar River Chinook population, the tributaries are believed to have played a relatively small role in the spatial distribution and overall abundance of the population. However, the availability of high-quality habitat in these areas is necessary to reduce the risk of natural disturbances (i.e. landslides such as those caused by the 2001 Nisqually earthquake) that could impact spawning areas in the mainstem Cedar. In addition, the Upper Cedar subarea provides increased spatial distribution of Chinook spawning aggregations along the mainstem of the Cedar River.

Each of these subareas has a relatively high level of watershed function, driven by low impacts from impervious surface and road crossings and relatively high levels of riparian and forest cover. Taylor/Downs Creek has experienced relatively moderate increases in storm volumes, while each of the Tier 2 sub-areas has relatively moderate or low percentages of wetlands.

Habitat Protection Hypotheses for the Cedar Chinook Tier 2 Subareas

The life stages most affected by existing high-quality habitat conditions are egg incubation, fry colonization and pre-spawning migrants. These critical life stages are sustained by protection of the following habitat attributes:

- Water quality (sediments, temperature, metals)
- Flows sufficient for pre-spawning migration
- Habitat quantity (pool habitats)
- Habitat attributes that contribute to the creation of pool habitats (riparian function, LWD, channel connectivity).

By comparing the survival of Chinook life stages under existing conditions and fully degraded habitat conditions, the EDT habitat model 'diagnoses' the potential of stream reaches for protection. The protection potential of reaches in the Cedar Tier 2 subareas is shown in Figure 4-5. This potential results from instream habitats, basin-wide conditions that create and maintain that habitat, and Chinook use of habitat in the reach. For this reason the Technical Committee has used the watershed evaluation and EDT to prepare technical recommendations for the entire subarea as well as individual stream reaches (Table 4-5).

Table 4-5: Protection Recommendations for Cedar Tier 2 Subareas (Upper Cedar, Lower Rock Creek, Taylor/Downs Creek, Peterson)

Basin-Wide Protection Hypotheses:

- Protect high watershed function by maintaining forest cover, riparian cover, and minimizing the amount of road crossings and impervious surface.
- Protect water quality to prevent adverse impacts to key life stages from fine sediments, metals (both in sediments and in water), and high temperatures. Adverse water quality impacts from road runoff and other sources of non-point source pollution should be prevented.
- Protect adequate flows during seasonal low flows to maintain the pre-spawning migrant life stage in Rock and Taylor/Downs Creek.
- The Upper Cedar River Watershed is protected by the City of Seattle as a water supply source. Existing elements of the City's Habitat Conservation Plan (HCP), such as allowing LWD in the mainstem channel and protecting forest cover through non-logging policies should be continued. No additional protection recommendations beyond those included in the HCP were developed for this subarea.

Reach-Specific Protection Hypotheses:

- Pool habitat and the habitat features that support the creation of pool habitat (LWD, riparian function, and channel connectivity) should be maintained in reaches with high protection potential in order to maintain key Chinook life stages. In Lower Rock Creek, protection efforts should begin with reaches 1, 3, and 5.
- Pool habitat, riparian function, LWD, and channel connectivity should be maintained in reaches with a relatively lower protection potential (Lower Rock Reach 5) to support spawning, egg incubation, and pre-spawn migration in downstream reaches 4A and 4B.
- In Taylor/Downs Creek, pool habitat and the habitat features that support the creation of pool habitat (LWD, riparian function, and channel connectivity) should be maintained in reach 1 in order to maintain key Chinook life stages in this subarea.
- In the Upper Cedar, protect LWD in the channel unless it poses a danger to dam operations.

Protection of these habitat attributes at the reach and basin scale is intended to maintain habitat conditions that are currently favorable to critical Chinook life stages. The Technical Committee hypothesizes that maintaining favorable conditions for these life stages in the Upper Cedar will ultimately support future sources of productivity and life history diversity for the Cedar River Chinook population. In Lower Rock and Taylor/Downs Creeks, protection of favorable habitat conditions for Chinook will maintain spatial distribution and reduce the risk of catastrophic environmental disturbances for the population.

Habitat Restoration Hypotheses for the Cedar Chinook Tier 2 Subareas

While restoration of the Tier 1 and migratory areas have a higher relative potential to improve the viability of the Cedar population, restoration in the Tier 2 tributaries is necessary to enhance the productivity of the population and ensure that high-quality habitat is available to the population in the event of natural environmental disturbances in the mainstem of the Cedar. In the tributary systems, the life stages most affected by degraded habitat conditions in these reaches are spawning, egg incubation, pre-spawn holding, and pre-spawn migration. These critical life stages are limited by degradation of the following habitat attributes:

- Habitat quantity (pool habitat types),
- Habitat quality (composed of channel confinement, riparian function, and large woody debris).
- Sediment load (fine sediments, turbidity, and embeddedness).
- Low flows.

By comparing the survival of Chinook life stages under existing conditions and fully restored habitat conditions, the EDT habitat model 'diagnoses' the potential of stream reaches for habitat restoration. The restoration potential of reaches in the Cedar Tier 2 subareas is shown in Figure 4-5. This potential results from instream habitats, basin-wide conditions that create and maintain that habitat, and Chinook use of habitat in the reach. For this reason the Technical Committee has used the watershed evaluation and EDT to prepare technical recommendations for the entire subarea as well as individual stream reaches. These recommendations are summarized in Table 4-6. The recommended changes to habitat attributes at the reach and basin scale are intended to create habitat conditions more favorable to critical Chinook life stages. The Technical Committee hypothesizes that improved conditions for these life stages will ultimately increase the spatial distribution and productivity of the Cedar River Chinook population.

Table 4-6: Restoration Recommendations for Cedar Tier 2 Subareas (Lower Rock Creek, Taylor/Downs Creek, Upper Cedar)

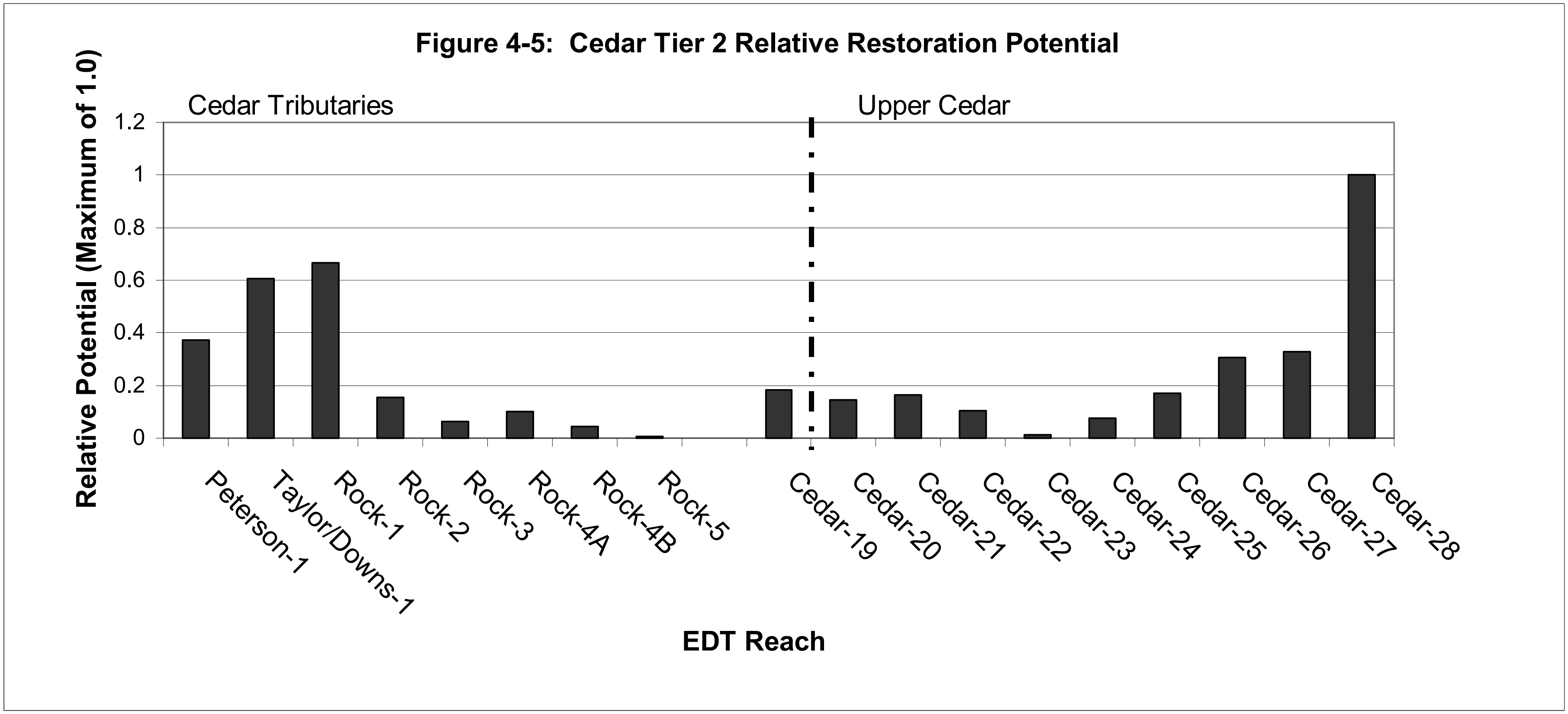
Basin-Wide Hypotheses:

- Re-vegetate riparian corridor with deciduous vegetation to provide nutrients and food sources.
- Continue to implement restoration activities identified in the City of Seattle's Cedar River Habitat Conservation Plan (HCP), such as restoring forest cover and riparian areas, decommissioning roads, removing fish passage barriers. No additional restoration recommendations beyond those included in the HCP were developed for this subarea.
- In Taylor/Downs Creek, key life stages would benefit from a reduction in stormwater flows that have increased bed scour and deposition of fine sediments.
- Restoration of seasonal low flows would support the pre-spawning holding life stage in Rock Creek.

Reach-Specific Hypotheses:

- Reduce channel confinement by removing bank armoring / hardening in Lower Rock reach 1.
- Increase pools by restoring large woody debris and riparian vegetation in Lower Rock reaches 1 and 2.
- Continue to implement restoration activities identified in the City of Seattle's Cedar River Habitat Conservation Plan (HCP).

These changes to habitat attributes at the reach and basin scale are intended to create habitat conditions more favorable to critical Chinook life stages in the Tier 2 subareas. The Technical Committee hypothesizes that improved conditions for these life stages in the Cedar Tributaries and the Upper Cedar will ultimately increase the spatial distribution, productivity, and diversity of the Cedar River Chinook population.



NOTE: The EDT habitat model determines the relative potential of a reach for salmon performance (a combination of productivity, abundance, and life history diversity) based on habitat conditions in the stream reach and the exposure of Chinook life stages to those habitat conditions. Similar habitat conditions may therefore result in different potentials due to differences in Chinook exposure. In addition, the salmon performance potential that exists in a reach may be due to upstream conditions (i.e. hydrologic conditions or sources of sediments and LWD) as well as conditions in the reach. For more information about habitat conditions, key life stages, and technical recommendations, please see the description of each subarea in the Conservation Strategy.

Conservation Strategy for the North Lake Washington (NLW) Chinook Population

The Bear Creek subarea covers approximately 32,100 acres or 50 square miles. The subarea is located in southern Snohomish County and northern King County and is composed of three main lowland stream tributaries: Bear Creek, Cottage Lake Creek, and Evans Creek. Bear Creek empties into the Sammamish River in the City of Redmond. Both Bear Creek and Cottage Lake Creek provide excellent spawning and rearing habitat for chinook, coho, sockeye, and kokanee salmon and steelhead trout.

Little Bear Creek is currently the least developed of the three main lowland tributaries to the Sammamish River (the other two are North and Swamp Creeks), and it has the least degraded habitat. As of 2001, between 25% and 40% of the North and Swamp Creek subareas were covered with impervious surface, and these sub-areas are located almost entirely within the urban growth area (2% of North Creek is outside the UGA). Little Bear Creek supports runs of chinook, sockeye, kokanee, and coho salmon. The basin encompasses a drainage area of approximately 15 square miles, begins in Snohomish County, flows southward into King County, and empties into the Sammamish River. Approximately 80 percent of the Little Bear Creek subarea is located within Snohomish County. Anadromous salmon and trout access almost all of this system, though there are some significant passage barriers to adults at low-flow periods and to juveniles during high flows.

Results of Technical Analyses

VSP Status and Relative Risk for North Lake Washington Chinook

For the WRIA 8 North Lake Washington Chinook population, the assessment of the VSP population parameters can be summarized as follows:

- Productivity: Reduced by habitat degradation. Currently, Chinook productivity is focused in the Bear Creek system (majority is in the Cottage Lake Creek tributary, followed by the Bear Creek mainstem).
- Diversity: Historically, it is likely that the variability in diversity within this population was low due to similar environmental regimes in the tributary sub-basins connected to the Sammamish River. It is likely that there were at least two different life-history trajectories for juvenile rearing: an early fry-migrant trajectory and a later smolt-migrant trajectory. The smolt-migrant life history is dominant in years of low flow and high flows. Hatchery strays are assumed to contribute to the natural spawning population. According to the Hatchery Science Review Group (HSRG, 2004), hatchery contribution rates higher than 1-5 percent would result in a high risk to naturally spawning Chinook from a Segregated Hatchery Program. However, it should be noted that the Co-Managers, in response to the HSRG's recommendations, have recommended that the Issaquah Creek Hatchery Program should be switched from a Segregated to an Integrated Hatchery Program (Lakey, 2004). If an integrated hatchery program is pursued, hatchery contribution rates to natural spawning could be as high as 30 percent with a low risk to the naturally spawning population.
- Spatial Structure: The spatial distribution among the core and satellite areas has narrowed considerably compared to historic conditions. Approximately 90% of the population currently resides in Bear Creek; historically it is likely that the NLW Chinook population was distributed fairly evenly among Bear, North, and Little

Bear Creeks. The historic contribution of Kelsey Creek and other Lake Washington tributaries used by the population is unknown.
Abundance: As shown in Chapter 3, the population abundance is at a very low level, driven primarily by reductions in habitat productivity and contraction of the spatial distribution. Hatchery strays are assumed to contribute to the current observed abundance. Consistently low abundance suggests that the North Lake Washington population is at risk from depensatory (Allee) effects, and therefore at risk of extinction.

At this time none of the four VSP attributes is sufficient to support viability of the population. Rehabilitation of all population attributes will be necessary to rehabilitate the population. The Technical Committee summarizes the relative risk posed to each of the four population attributes as follows:

- Productivity: High
- Diversity: Moderate to High depending on the level of hatchery contribution to total spawners (contribution rates higher than 1-5% would result in high risk to the population)
- Spatial Structure: High
- Abundance: High

The Technical Committee suggests the following hypotheses based on this assessment of population attributes and relative risk:

- All population attributes require rehabilitation if the NLW Chinook population is to be viable.
- Of the four population attributes, the greatest extinction risk comes from reduction in habitat productivity and the severe contraction of the population distribution.
- Efforts to restore habitat productivity should include the Sammamish River and Lake Washington as well as the North Lake Washington tributaries.
- Hatchery influences pose a significant risk to the genetic diversity of the population.

Watershed Evaluation Framework for North Lake Washington
Following the assessment of Chinook salmon population attributes, the Technical Committee stratified subareas within each of the three WRIA 8 Chinook populations based on the degree of fish use and the level of watershed function. Using Chinook salmon demographic information to assess the relative abundance within subareas and the frequency that Chinook uses subareas, the NLW subareas can be organized as follows:

- Core areas of high Chinook abundance and frequent use – Upper Bear (Reaches 8-14), Lower Bear (Reaches 1-7), and Cottage Lake Creek (Reaches 1-5).
- Satellite areas of moderate Chinook abundance and moderately frequent use – Evans (Reaches 1-7), Upper North, Lower North, Upper Swamp, Lower Swamp, Little Bear (Reaches 1-12), and Kelsey Creeks
- Migratory areas – Sammamish River, Lakes Washington and Union, Ship Canal, Nearshore and Estuary.

- Episodic areas with infrequent Chinook use – McAleer Creek, Juanita Creek, Thornton Creek, May Creek, Coal Creek.

The relative watershed function of these subareas can then be assessed by rating factors that sustain function and factors that limit function:

- Factors sustaining watershed function: wetland area, forest cover, riparian cover, and gradient less than 2%.
- Factors limiting watershed function: Impervious surface, flow volume, road crossings, gradient >4%.

Following an assessment of watershed function factors listed above, the subareas that contribute to the North Lake Washington Chinook population can be organized as follows:

- High Function – Bear Creek Upper, Bear Creek Cottage Lake Creek.
- Moderate Function – Bear Creek Evans, Bear Creek Lower, Little Bear Creek, North Creek, May Creek.
- Low Function –Swamp Creek Upper, Swamp Creek Lower, Kelsey Creek, McAleer Creek, Juanita Creek, Thornton Creek, Sammamish Valley Upper, Sammamish Valley Lower, Lakes Washington and Union, Ship Canal, Nearshore and Estuary.

By combining the fish use and watershed function ratings, the Technical Committee has stratified the subareas that contribute to the NLW Chinook population as follows:

- Tier 1 – Bear Creek Upper, Bear Creek Cottage Lake Creek, Bear Creek Lower, Migratory and Rearing Areas (Sammamish River, Lakes Washington and Union, Ship Canal, Nearshore and Estuary).
- Tier 2 – Bear Creek Evans, Upper North Creek, Lower North Creek, Little Bear Creek, Kelsey Creek.
- Tier 3 – McAleer Creek, Juanita Creek, Thornton Creek, Swamp Creek Upper, Swamp Creek Lower.

Kelsey Creek is included as a Tier 2 subarea at this time due to the abundance and frequency of Chinook use. More research is needed to understand the genetic origin of the Chinook that use Kelsey Creek and why these fish continue to use the system despite the relatively low level of watershed function. Due to these outstanding questions, restoration and protection actions in the Kelsey Creek subarea should be considered experimental.

The Technical Committee suggests the following hypotheses based on the Watershed Evaluation Framework:

- Protection and restoration actions will be necessary in both Tier 1 and Tier 2 areas to rehabilitate NLW Chinook productivity, diversity, spatial distribution, and abundance.
- Watershed function can be improved by improving watershed conditions that limit function (i.e. total impervious area and road crossings) and enhancing factors that sustain function (i.e. total forest cover and riparian forest cover).

- Actions in areas of higher watershed function should focus on protecting habitat attributes and habitat-forming processes; actions in areas of moderate or low watershed function will require restoration of key habitat attributes and habitat-forming processes.
- Actions in the Tier 3 subareas should focus on protecting and enhancing water quality and hydrologic integrity.

EDT Habitat Model Results and Recommendations for North Lake Washington Chinook

The results of the EDT diagnosis for each subarea, and the protection and restoration hypotheses developed based on the application of VSP, the Watershed Evaluation Framework, and EDT are summarized in the following section. An appendix with a description of the EDT stream reaches is also included at the end of this document (C-6).

Habitat Protection and Restoration Hypotheses in the NLW Chinook Tier 1 Subareas

The Tier 1 subareas include Upper Bear (EDT Reaches 8-14), Lower Bear (EDT Reaches 1-7) and Cottage Lake Creek (EDT Reaches 1-5). All three of these subareas are core areas for Chinook use. Cottage Lake Creek and Upper Bear Creek have relatively high levels of watershed function resulting from a low impervious surface percentage, few road crossings, and a high level of forest cover and riparian forest. Lower Bear has a moderate level of watershed function, due primarily to increased impervious surface and storm flow volumes, along with reductions in forest cover and riparian cover.

Habitat Protection Hypotheses for the NLW Chinook Tier 1 Subareas

Recommendations for these subareas focus on protection of the habitat processes and structures that make these areas a significant source of production for the North Lake Washington Chinook population. Using the EDT habitat model, the Technical Committee hypothesizes that in all three Tier 1 subareas the life stages most affected by existing high-quality habitat conditions are egg incubation, fry colonization and pre-spawning migrants. These critical life stages are sustained by protection of the following habitat attributes:

- Water quality (low levels of fine sediments, turbidity and metals, low water temperatures)
- Flows (sufficient flows during seasonal low flow periods)
- Habitat quantity (pool habitat areas to limit exposure to predators and high flow events)
- Habitat attributes that contribute to the creation of pool habitat area and provide cover (riparian function, LWD, channel connectivity).

By comparing the survival of Chinook life stages under existing conditions and fully degraded habitat conditions, the EDT habitat model ‘diagnoses’ the potential of stream reaches for protection. This potential results from instream habitats, basin-wide conditions that create and maintain that habitat, and Chinook use of habitat in the reach. For this reason the Technical Committee has used the watershed evaluation and EDT to prepare technical recommendations for the entire subarea (Table 4-7) as well as individual stream reaches (Table 4-8).

Table 4-7: Basin-Wide Protection Recommendations for Tier 1 Subareas (Upper Bear, Lower Bear, Cottage Lake Creek)

- Headwater areas, wetlands, and sources of groundwater (e.g. seeps and springs) should be protected to maintain hydrologic integrity and a temperature regime that supports Chinook life stages.
- Riparian function (including overbank flows, vegetated streambanks, and groundwater interactions) should be protected throughout the basin to protect key Chinook life stages.
- Key Chinook life stages are maintained by protecting water quality to prevent adverse impacts from fine sediments, metals (both in sediments and in water), and high temperatures.
- The continued implementation of land use policies that protect critical areas (including groundwater sources), forested land cover, and minimize impervious surface will contribute to the protection of critical Chinook life stages.
- Adverse impacts from non-point source pollution (particularly road runoff) should be prevented through stormwater best management practices and the minimization of the number and width of roads in the basin.
- Provide adequate stream flow to allow upstream migration and spawning by establishing instream flow levels, enforcing water right compliance, and providing for hydrologic continuity.
- The impact of surface water and groundwater withdrawals on flow conditions for salmon life stages should be investigated and addressed.
- In order to maintain the existing high relative level of watershed function and hydrologic integrity (especially maintenance of sufficient baseflows), forest cover, wetland areas, and riparian forest should be maintained and increases in impervious surface and road crossings should be minimized.
- Sources of groundwater inflow to Cold Creek should be identified and protected to maintain cold temperatures and hydrologic integrity in Cottage Lake Creek and lower Bear Creek.
- Provide adequate stream flow to allow upstream migration and spawning by establishing instream flow levels, enforcing water right compliance, and providing for hydrologic continuity.
- Road crossings should be minimized to maintain floodplain connectivity.
- Spawning areas in Cottage Lake Creek are the most significant source of productivity and abundance for the North Lake Washington Chinook population and should be protected.
- Spawning areas Bear Creek are a significant source of productivity and abundance for the North Lake Washington Chinook population and should be protected.
- Opportunities to retrofit existing roadways (especially Avondale Road and SR-520) and commercial / industrial areas with stormwater treatment BMPs should be pursued.

Table 4-8: Tier 1 Reach-Level Protection Recommendations (Upper Bear, Lower Bear, Cottage Lake Creek)
Reaches are listed in order of Relative Protection Priority

Tier 1 Subarea:	*Critical Chinook Life Stages for Protection:*	*LWD, Riparian Function, and Channel Connectivity should be protected in the following reaches:*
Upper Bear	Pre-Spawning Migrant; Fry Colonization	14, (tie 13 & 9), (tie 8, 10-12)
Lower Bear	Pre-Spawning Migrant; Fry Colonization; 0-Age Active Rearing	2, 7, 6, (tie 3 & 5), (tie 1 & 4)
Cottage Lake Creek	Pre-Spawning Migrant; Fry Colonization	3, 2, (tie 1 & 4 & 5)

- Areas of relatively high-quality habitat forming features (LWD, riparian function, and channel connectivity) providing cover and refuge for critical life stages should be protected and maintained. Table 4-8 lists the reaches in each subarea beginning with reaches that have the relatively most intact habitat conditions.

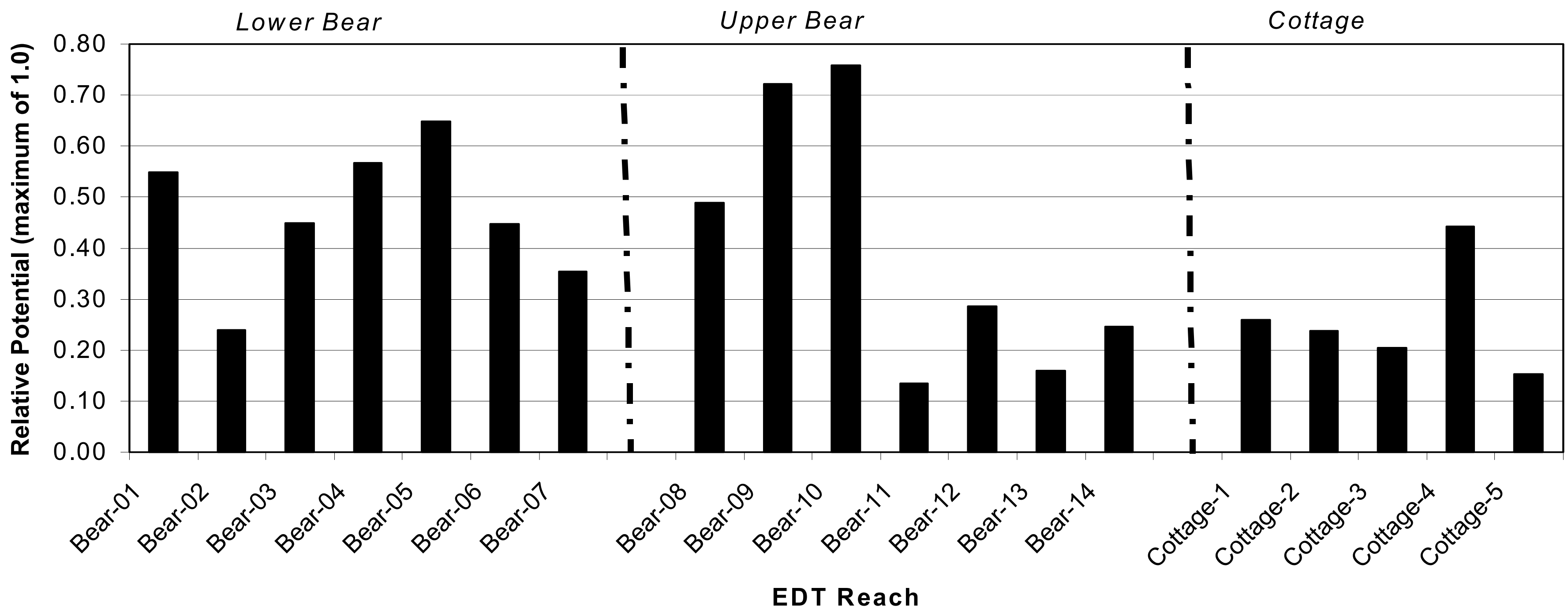
Based on the three analytical tools described above, the Technical Committee hypothesizes that conservation actions based on the basin-wide and reach-specific protection recommendations will maintain habitat conditions that are currently favorable to critical Chinook life stages. The Technical Committee hypothesizes that actions based on these recommendations will maintain favorable conditions for these life stages in each of the three Tier 1 subareas (Upper Bear, Lower Bear, and Cottage Lake Creeks) and will ultimately support the existing sources of productivity and life history diversity for the North Lake Washington Chinook population.

Habitat Restoration Hypotheses for the NLW Chinook Tier 1 Subareas
Although protection of existing high-quality habitat and habitat-forming processes is the primary objective in the Tier 1 subareas, restoration and enhancement of watershed function and instream habitat attributes would contribute to the rehabilitation of NLW Chinook population attributes, particularly the productivity of the population. Based on the EDT habitat model, the Technical Committee hypothesizes that the life stages most affected by degraded habitat conditions in these reaches are egg incubation, juvenile active rearing (0-age), and fry colonization. These critical life stages are limited by degradation of the following habitat attributes:

- Sediment load (fine sediments)
- Channel stability (bed scour, riparian function, LWD)
- High flows
- Habitat diversity (channel confinement, riparian function, and LWD)
- Predation, interactions with non-native fish species, and elevated water temperatures.

By comparing the survival of Chinook life stages under existing conditions and fully restored habitat conditions, the EDT habitat model 'diagnoses' the potential of stream reaches for habitat restoration. The restoration potential of reaches in the Tier 1 subareas is shown in Figure 4-6. This potential results from instream habitats, basin-wide conditions that create and maintain that habitat, and Chinook use of habitat in the reach. For this reason the Technical Committee has used the watershed evaluation and EDT to prepare technical recommendations for the entire subarea as well as individual stream reaches. These recommendations are summarized in Table 4-9. The recommended changes to habitat attributes at the reach and basin scale are intended to create habitat conditions more favorable to critical Chinook life stages. The Technical Committee hypothesizes that improved conditions for these life stages will ultimately increase the productivity, spatial distribution, and life history diversity of the North Lake Washington Chinook population.

Figure 4-6: North Lake Washington Chinook Relative Restoration Potential in Tier 1 Sub-Areas (Upper Bear, Lower Bear, and Cottage Creeks)



NOTE: The EDT habitat model determines the relative potential of a reach for salmon performance (a combination of productivity, abundance, and life history diversity) based on habitat conditions in the stream reach and the exposure of Chinook life stages to those habitat conditions. Similar habitat conditions may therefore result in different potentials due to differences in Chinook exposure. In addition, the salmon performance potential that exists in a reach may be due to upstream conditions (i.e. hydrologic conditions or sources of sediments and LWD) as well as conditions in the reach. For more information about habitat conditions, key life stages, and technical recommendations, please see the description of each subarea in the Conservation Strategy.

Table 4-9: Basin-Wide and Reach-Specific Restoration Recommendations for Tier 1 Subareas (Upper Bear, Lower Bear, Cottage Lake Creek)

Basin-Wide Recommendations:

- Egg incubation and fry colonization life stages would benefit from source control best management practices that reduce fine sediment inputs to the system. Additional studies are needed to improve our understanding of the sources of fine sediment in these subareas.
- Fry colonization life stage would benefit from riparian restoration to reduce peak water temperatures that favor non-native species and provide future sources of LWD.
- Egg incubation and fry colonization life stages would benefit from stormwater management practices that reduce sediment inputs from bed scouring high flows.
- Egg incubation and fry colonization life stages would benefit from riparian restoration to provide future sources of LWD that can improve channel stability and contribute to the creation of pool habitat areas with suitable cover.
- Fry colonization life stage would benefit from a review of hatchery outplant policies to ensure that predation on wild Chinook is minimized.

Reach-Specific Recommendations:

- Fry colonization life stage would benefit from the addition of LWD to create pool habitat areas that reduce exposure to predators.
- Fry colonization and juvenile active-rearing life stage would benefit from reduction in channel confinement (particularly in Cottage Lake Creek reaches 1 and 2 and the Lower Bear reaches) and the addition of LWD to create pool habitat areas that reduce exposure to predators and high flows.
- Egg incubation life stage would benefit from the addition of LWD to create pool habitat areas that trap fine sediments. This recommendation does not address the causes of the sediment problem, and is intended to complement the source control and flow control measures identified as part of the basin-wide hypotheses.

Restoration of Migratory and Rearing Areas for NLW Chinook

While enhancement of the Tier 1 subareas is important for rehabilitation of the NLW population, restoration of the Sammamish River and Lake Washington would have a significant beneficial impact on key Chinook life stages in Tier 1 and Tier 2 subareas. The EDT results provide a relative sense of the restoration potential in the Sammamish River and the NLW tributaries. The restoration potential of the Sammamish River is approximately equal to the combined restoration potential in Bear, North, and Little Bear Creeks, and is therefore a critical element of restoring Chinook in Bear Creek and several of the Tier 2 subareas. In the Sammamish River, the key life stages are juvenile rearing and pre-spawning migrants. These critical life stages are limited by degradation of the following habitat attributes:

- Habitat quantity (pool habitat areas with adequate cover),
- Habitat diversity (LWD and riparian function)
- Water quality (temperatures that limit migration)

Restoration of these habitat attributes will benefit juvenile rearing and adult migration in the Sammamish River. Restoration of habitat conditions that support these life stages is intended to increase the productivity, spatial distribution, and life history diversity of the

North Lake Washington Chinook population. Restoration hypotheses for the Sammamish River are summarized in Table 4-10.

Although the restoration potential is not as high as the Sammamish River, Lake Washington restoration would also provide significant benefits to NLW Chinook. Based on the EDT habitat modeling effort, juvenile migrants would benefit from actions that reduce predation by cutthroats and other predators. Predation on juvenile Chinook appears to be driven primarily by conditions that limit cover for Chinook and increase exposure to predators, such as bank hardening, steep slopes, and a lack of LWD and shoreline vegetation. Restoration actions for Lake Washington are summarized in Table 4-10.

Table 4-10: Restoration Recommendations for NLW Migratory and Rearing Areas

Sammamish River:

- Restore floodplain connections and promote meandering as a way to increase connections with cool groundwater sources. Re-meandering and levee setbacks should focus on Sammamish River reaches 3-6. Higher priority should be placed on upstream re-meandering projects so that the temperature benefits of cool groundwater can impact multiple downstream reaches of the Sammamish River.
- Restoration in Sammamish River reaches 1 and 2 should focus on the addition of backwaters pool areas, restoration of side channels, and the use of LWD as cover.
- Big LWD and jams may be necessary to restore functions and processes. Set back levees, need bigger scale projects than current projects.
- Restore riparian vegetation along the mainstem Sammamish and the Sammamish River tributaries. Restoration of tributaries is especially important as a means of cooling sources of inflow to the mainstem river.
- Raise the overall water level in the river channel. This can be achieved by inducing more groundwater flow, adding LWD, and increasing habitat complexity in the river channel.
- The impact of surface water and groundwater withdrawals on flow conditions for salmon life stages and the creation and maintenance of habitat structures should be investigated and addressed.
- Further investigations are needed into the potential for chemical contamination near the mouth of the Sammamish River at the site of the former cement plant near mouth.

Lake Washington:

- Reduce bank hardening by replacing bulkheads and rip-rap with sandy beaches with gentle slopes designed to maximize littoral areas with a depth of less than 1 meter.
- Reconnect and enhance small creek mouths as juvenile rearing areas. Historically these small creeks had sandy deltas at the creek mouth and were associated with wetland complexes. Restoration efforts should start at the mouth of the Sammamish River, with other high potential reaches around Union Bay and the mouths of Kelsey and May Creeks.
- Protect and restore water quality in small tributaries.
- Juvenile Chinook in the NLW population are less shoreline-oriented than juveniles from the Cedar River. More information is needed about the trajectories of NLW juvenile Chinook in Lake Washington, particularly when they move offshore.
- Shoreline processes of Lake Washington have been changed by the regulated maximum one foot rise and fall of the lake. Therefore, the removal of bank

hardening structures may not be sufficient to create sandy beaches and augmentation of sediment supplies may be necessary.
- The outmigration of juvenile Chinook would benefit from improved shoreline connectivity. The use of mesh dock surfaces and/or community docks would reduce the severity of predation on juvenile Chinook.
- Habitat in the smaller Lake Washington tributaries (Tier 3 streams such as Thornton, McAleer, and Lyon) should be restored for coho so that production of cutthroat trout which prey on juvenile Chinook in Lake Washington is reduced.
- Consider increases in fishing limits for cutthroat trout.

Ship Canal, Ballard Locks, Estuary, and Nearshore:
See migratory and rearing recommendations for Cedar River Chinook in Table 4-4.

Habitat Protection and Restoration Hypotheses in the NLW Chinook Tier 2 Subareas

The NLW Tier 2 subareas include Evans, North, Little Bear, and Kelsey Creeks. Historically, the NLW Chinook spawning was distributed fairly evenly among these areas and the Bear Creek system. Restoration of these subareas is necessary to increase the spatial distribution and productivity of the NLW Chinook population. The Technical Committee hypothesizes that restoration and enhancement of habitat conditions in these subareas will reduce the risk of extinction that results from having the population centered in one spawning area (Bear Creek). In addition, the Technical Committee hypothesizes that increased productivity of the Tier 2 areas will also increase the viability of the overall population.

The Evans, North, and Little Bear systems all had moderate relative watershed impact ratings, with impacts primarily from impervious area and flow volume increases. Watershed function in these subareas is moderate, although the Evans subarea was rated high due to relatively intact wetland, forest, and riparian areas. The Kelsey Creek subarea has relatively high watershed impacts limiting watershed function, primarily due to impervious area, flow volume increases, and relatively high road crossings. Mitigative factors in the Kelsey system are rated moderate, and include relatively high levels of wetland area in lower Kelsey. Forest and riparian cover are rated low in both upper and lower Kelsey Creek.

Habitat Protection Hypotheses for the NLW Chinook Tier 2 Subareas

Recommendations for these Tier 2 subareas focus on protection of intact habitat processes and structures. Using the EDT habitat model, the Technical Committee hypothesizes that in all subareas the Chinook life stages most affected by existing high-quality habitat conditions are egg incubation, fry colonization and pre-spawning migrants. These critical life stages are sustained by protection of the following habitat attributes:

- Water quality (low levels of fine sediments, turbidity and metals, low water temperatures)
- Flows (sufficient flows during seasonal low flow periods)
- Habitat quantity (pool habitat areas to limit exposure to predators and high flow events)
- Habitat attributes that contribute to the creation of pool habitat area and provide cover (riparian function, LWD, channel connectivity).

Degradation of these habitat attributes would reduce the potential of these habitats to support Chinook populations. The Technical Committee has used the watershed evaluation and EDT to prepare protection recommendations for the entire subarea (Table 4-11) as well as individual stream reaches (Table 4-12).

Table 4-11: Basin-Wide Protection Recommendations for Tier 2 Subareas (Evans, Little Bear, North, and Kelsey Creeks)

- Protect water quality to prevent adverse impacts to key life stages from fine sediments, metals (both in sediments and in water), and high temperatures. Adverse impacts from road runoff should be prevented.
- Forest cover and wetlands should be protected throughout each of the subareas to maintain watershed function and hydrologic integrity (especially maintenance of sufficient baseflows), and protect water quality.
- Road crossings should be minimized to maintain floodplain connectivity
- Provide adequate stream flow to allow upstream migration and spawning by establishing instream flow levels, enforcing water right compliance, and providing for hydrologic continuity.

Table 4-12: NLW Chinook Tier 2 Reach-Level Protection Recommendations (Evans, Little Bear, North, and Kelsey Creeks)
Reaches are listed in order of Relative Protection Priority

Tier 1 Subarea:	*Critical Chinook Life Stages for Protection:*	*LWD, Riparian Function, and Channel Connectivity should be protected in the following reaches:*
Evans	Pre-Spawning Migrant, Fry Colonization	1; 6-7 (tie); 2-4 (tie); 5
Little Bear	Pre-Spawning Migrant, Fry Colonization	10-11 (tie); 3; 4; 7-8 (tie); 2 & 5 (tie); 6; 1
Upper North	Pre-Spawning Migrant, Fry Colonization	10; 9; 6; 8; 7; 12; 11
Lower North	Pre-Spawning Migrant, 0-age active rearing; Fry Colonization	1; 5; 4; 3; 2
Kelsey	Pre-Spawning Migrant, Fry Colonization	Kelsey 3; Valley 7; Goff 1, Kelsey 4, and West Trib 4-5 (tie); Kelsey 8; Valley 1; West Trib 1; Kelsey 1 (these reaches represent the top 10 in the Kelsey system; remaining reaches are not listed due to limited space)

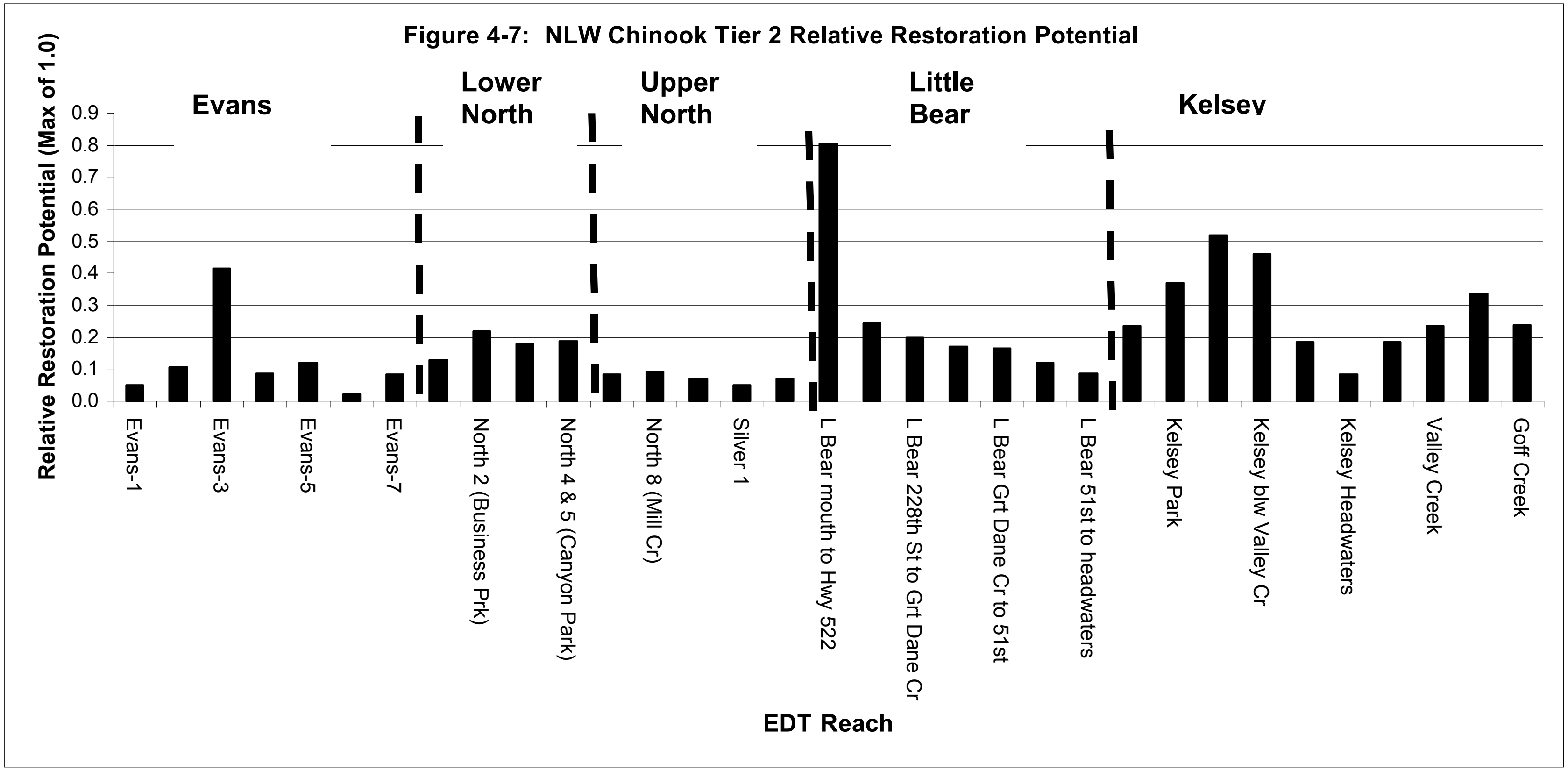
When the NLW Tier 2 systems are compared, the reaches with the most relatively intact habitat (based on LWD, riparian function, and channel connectivity) are as follows:

1. North 10
2. North 1 and 9 (tie);
3. North 6;
4. Kelsey 3;
5. Little Bear 10 and 11; North 8; Valley 7

Habitat Restoration Hypotheses for the NLW Chinook Tier 2 Subareas
While restoration of the Tier 1 and migratory areas have a higher relative potential to improve the viability of the NLW population, restoration in the Tier 2 tributaries is necessary to enhance the productivity of the population and ensure that high-quality habitat is available to the population in the event of natural environmental disturbances in the Bear Creek spawning areas. As might be expected from the watershed evaluation factors described above, these systems are primarily impacted by habitat changes associated with urban development. In these tributary systems, the life stages most affected by degraded habitat conditions are egg incubation, fry colonization, and pre-spawning holding. These critical life stages are limited by degradation of the following habitat attributes:

- Egg incubation – sediment load, bed scour, flows
- Fry colonization – flows, riparian cover, channel connectivity, LWD, and bed scour
- Pre-spawn holding – riparian cover, channel connectivity, LWD, pool habitats, flows

The restoration potential of reaches in these subareas is shown in Figure 4-7 below.



NOTE: The EDT habitat model determines the relative potential of a reach for salmon performance (a combination of productivity, abundance, and life history diversity) based on habitat conditions in the stream reach and the exposure of Chinook life stages to those habitat conditions. Similar habitat conditions may therefore result in different potentials due to differences in Chinook exposure. In addition, the salmon performance potential that exists in a reach may be due to upstream conditions (i.e. hydrologic conditions or sources of sediments and LWD) as well as conditions in the reach. For more information about habitat conditions, key life stages, and technical recommendations, please see the description of each subarea in the Conservation Strategy.

Conservation Strategy for Issaquah Creek Chinook

The Issaquah Creek subarea encompasses approximately 61 square miles of King County. The creek's headwaters flow from the steep slopes of Cougar, Squak, Tiger, and Taylor mountains into Lake Sammamish. The subarea includes Issaquah Creek and its tributaries: Holder Creek, Carey Creek, Fifteenmile Creek, and McDonald Creek. It also includes the north and east forks of Issaquah Creek and Tibbets Creek. (Tibbets Creek is not actually a tributary to Issaquah Creek, but it shares a common floodplain with the mainstem during large flood events.) The Issaquah Creek subarea supports chinook, coho, and kokanee salmon and steelhead trout. It may also support bull trout. The middle and upper sections of Issaquah Creek have exceptional fish habitat; Carey Creek and Holder Creek, in particular, provide excellent habitat for salmon. The Issaquah Salmon Hatchery, which is managed by the Washington Department of Fish and Wildlife, currently produces Chinook and coho salmon, as well as Lake Washington steelhead trout. All fish not needed for production are allowed to spawn in Issaquah Creek. In 2000, the hatchery began mass-marking all Chinook and coho juveniles leaving the hatchery as a means of distinguishing returning hatchery adults from naturally produced fish.

Results of Technical Analyses

VSP Status and Relative Risk for Issaquah Creek Chinook

As described in the VSP Framework (Appendix C), the application of VSP guidance to a population that is largely driven by hatchery operations is problematic. While natural spawning does occur in the Issaquah basin, the majority of this is from hatchery fish passed above the Issaquah Hatchery weir, along with some natural-origin adults that are likely the first-generation progeny of hatchery Chinook. In light of recent (2003) Chinook spawner surveys showing a high hatchery contribution rate to the spawning grounds, hatchery-origin fish (from Issaquah and other Puget Sound hatcheries) are considered to pose a risk to the viability of the Cedar and North Lake Washington independent Chinook populations. As described in Chapter 3, additional data is needed regarding stray rates and the impact of straying on genetic diversity in WRIA 8. Additional genetic analyses are being conducted to assess the amount of genetic diversity that currently exists in WRIA 8, and the genetic similarity to hatchery Chinook, and a report is due in February 2005. This information will be shared with the Puget Sound PSTRT to enhance the analytical basis for independent population determinations in WRIA 8. According to the Hatchery Science Review Group (HSRG, 2004), hatchery contribution rates higher than 1-5 percent would result in a high risk to naturally spawning Chinook from a Segregated Hatchery Program. However, it should be noted that the Co-Managers, in response to the HSRG's recommendations, have recommended that the Issaquah Creek Hatchery Program should be switched from a Segregated to an Integrated Hatchery Program (Lakey, 2004). If an integrated hatchery program is pursued, hatchery contribution rates to natural spawning could be as high as 30 percent with a low risk to the naturally spawning population.

Watershed Evaluation Framework for Issaquah Creek

Using Chinook salmon demographic information to assess the relative abundance within subareas and the frequency that subareas are used by Chinook, the Issaquah subareas can be organized as follows (please note that for the Issaquah population this demographic information is heavily influenced by hatchery operations):

- Core areas of high Chinook abundance and frequent use (all subareas with observed Chinook use were included as core areas in order to be conservative – Issaquah abundance and frequency of abundance is driven by hatchery management decisions and does not necessarily reflect Chinook habitat preference): Upper Issaquah (Carey

and Holder), Middle Issaquah (reaches 11-12), Lower Issaquah (reaches 1-10), Fifteenmile Creek, East Fork Issaquah, North Fork Issaquah
- Satellite areas of moderate Chinook abundance and moderately frequent use – none.
- Migratory areas – Lakes Sammamish, Washington, and Union, Sammamish River, Ship Canal, Nearshore and Estuary.
- Episodic areas of low Chinook abundance and infrequent use – McDonald Creek, Tibbetts Creek.

The relative watershed function of these subareas can then be assessed by rating factors that sustain function and factors that limit function:

- Factors sustaining watershed function – Wetland area, forest cover, riparian cover, gradient less than 2%.
- Factors limiting watershed function – Impervious surface, flow volume, road crossings, gradient greater than 4%.

Following an assessment of watershed function factors listed above, the subareas that contribute to the Issaquah Chinook population can be organized as follows:

- High Function – Carey/Holder Creeks (Upper Issaquah), Middle Issaquah, Fifteenmile, North Fork
- Moderate Function – Lower Issaquah, East Fork, McDonald, Tibbetts
- Low Function – Migratory areas (Lake Sammamish, Sammamish River, Lake Washington, Lake Union, Nearshore and Estuary).

By combining the fish use and watershed function ratings, the Technical Committee has stratified the subareas that contribute to the Issaquah population as follows:

- Tier 1 – Carey/Holder Creeks (Upper Issaquah), Middle Issaquah, Lower Issaquah, Fifteenmile Creek, North Fork, East Fork, Migratory and Rearing Areas (Sammamish River, Lakes Washington and Union, Ship Canal, Nearshore and Estuary).
- Tier 2 – None
- Tier 3 – McDonald Creek, Tibbetts Creek.

The Technical Committee suggests the following hypotheses based on the Watershed Evaluation Framework:

- Protection actions will be necessary in Tier 1 sub-basins to maintain favorable habitat conditions that support use by salmonids.
- Watershed function can be improved by improving watershed conditions that limit function (especially total impervious surface and the number of road crossings) and protecting factors that sustain function (especially forest cover and riparian forest).
- Actions in areas of high watershed function (Carey/Holder and Fifteenmile Creeks, Middle Issaquah, and North Fork Issaquah) should focus on protecting habitat attributes and habitat-forming processes to prevent any reduction in relative watershed function; actions in areas of moderate watershed function should focus on enhancement of habitat-forming processes and key habitat attributes.
- Actions in the Tier 3 subareas should focus on protecting and enhancing water quality and hydrologic integrity.

EDT Habitat Model Results and Recommendations for Issaquah Creek

The results of the EDT diagnosis for each subarea, and the protection and restoration hypotheses developed based on the application of VSP, the Watershed Evaluation Framework, and EDT are summarized in the following section. An appendix with a description of the EDT stream reaches is also included at the end of this document (C-6).

Habitat Protection and Restoration Hypotheses for the Issaquah Chinook Tier 1 Subareas

The Tier 1 subareas include Carey/Holder and Fifteenmile Creeks, Lower (reaches 1-10) and Middle (reaches 11-12) Issaquah Creek, and the North and East Forks of Issaquah Creek. Each of these subareas is considered a core area, but there are differences in the relative level of watershed function. The moderate function subareas (Lower Issaquah and East Fork) have relatively high impacts from increases in impervious surface and relatively moderate impacts from increased stormflow volumes. For both the moderate and high function subareas, forest cover and riparian forest cover are relatively intact and should be maintained to support watershed function.

Habitat Protection Hypotheses for the Issaquah Chinook Tier 1 Subareas

Recommendations for the Tier 1 subareas focus on protection of the habitat processes and structures that make these areas a significant source of production for the Issaquah population. Using the EDT habitat model, the Technical Committee hypothesizes that the life stages most affected by existing high-quality habitat conditions in the Tier 1 subareas are egg incubation, fry colonization and pre-spawning migrants. These critical life stages are sustained by protection of the following habitat attributes:

- Water quality (low levels of fine sediments, turbidity and metals, low water temperatures)
- Flows (sufficient flows during seasonal low flow periods)
- Habitat quantity (pool habitat areas to limit exposure to predators and high flow events)
- Habitat attributes that contribute to the creation of pool habitat area and provide cover (riparian function, LWD, channel connectivity).

By comparing the survival of Chinook life stages under existing conditions and fully degraded habitat conditions, the EDT habitat model 'diagnoses' the potential of stream reaches for protection. The protection potential of reaches in the Tier 1 subareas is shown in Figure 4-9. . This potential results from instream habitats, basin-wide conditions that create and maintain that habitat, and Chinook use of habitat in the reach. For this reason the Technical Committee has used the watershed evaluation and EDT to prepare technical recommendations for the entire subarea (Table 4-13) as well as individual stream reaches (Table 4-14.

Table 4-13 Basin-Wide and Reach-Specific Protection Recommendations for Issaquah Creek Tier 1 Subareas

Basin-Wide Protection Hypotheses:

- Headwater areas, wetlands, and sources of groundwater (e.g. seeps and springs) should be protected to maintain hydrologic integrity and a temperature regime that supports Chinook life stages.
- Key Chinook life stages are maintained by protecting water quality to prevent adverse impacts from fine sediments, metals (both in sediments and in water), and high temperatures.
- The continued implementation of land use policies that protect critical areas (including groundwater sources), forested land cover, and minimize impervious

surface will contribute to the protection of critical Chinook life stages.
- Adverse impacts from road runoff should be prevented through stormwater best management practices and the minimization of the number and width of roads in the basin. Opportunities to retrofit existing roadways with stormwater treatment BMPs should be pursued.
- Provide adequate stream flow to allow upstream migration and spawning by establishing instream flow levels, enforcing water right compliance, and providing for hydrologic continuity. Flows in the east and north forks should be maintained and improved to avoid stranding of Chinook.
- In order to maintain the existing high relative level of watershed function and hydrologic integrity (especially maintenance of sufficient baseflows), forest cover, wetland areas, and riparian forest should be maintained and increases in impervious surface and road crossings should be minimized.
- Road crossings should be minimized to maintain floodplain connectivity.
- Riparian function (including overbank flows, vegetated streambanks, and groundwater interactions) should be protected throughout the basin to protect key Chinook life stages.
- Sources of groundwater should be identified and protected to maintain cold temperatures and hydrologic integrity. Carey and Holder creeks are believed to be important cold water sources and should be protected.

Table 4-14: Issaquah Creek Tier 1 Reach-Level Protection Recommendations
Reaches are listed in order of Relative Protection Priority

Tier 1 Subarea:	*Critical Chinook Life Stages for Protection:*	*LWD, Riparian Function, and Channel Connectivity should be protected in the following reaches:*
Carey/Holder	Pre-Spawning Migrant; Fry Colonization; Egg Incubation	Holder 2; Carey 4; Holder 3; (tie Carey 1-3 & Holder 1)
Middle Issaquah	Pre-Spawning Migrant; Fry Colonization; Egg Incubation	11; 12
Lower Issaquah	Pre-Spawning Migrant; Fry Colonization; Egg Incubation	(tie 7 & 9), (tie 1-2), (tie 6, 8, & 10); (tie 3-5)
Fifteenmile	Pre-Spawning Migrant; Fry Colonization; Egg Incubation	2; 1
North Fork	Pre-Spawning Migrant; Fry Colonization; Egg Incubation	1; 3; 2
East Fork	Pre-Spawning Migrant; Fry Colonization; Egg Incubation	3; 2 and 1

Reach-Level Protection Hypotheses (based on Table 4-14):
- Habitat forming features (LWD, riparian function, and channel connectivity) that provide cover and refuge for critical life stages should be protected and maintained, starting with

Carey Creek (especially reach 4), Holder Creek (especially reach 2), EF Issaquah reach 2, and Fifteenmile Creek reach 2.
- LWD in reaches 1 and 2 should be maintained – restoration efforts in the state park reaches should proceed cautiously to avoid adverse impacts to existing habitat.

Protection of habitat attributes at the reach and basin scale is intended to maintain habitat conditions that are currently favorable to critical Chinook life stages. The Technical Committee hypothesizes that maintaining favorable conditions for these life stages will ultimately support the existing sources of productivity and life history diversity for the Issaquah Chinook population.

Issaquah Tier 1 Restoration Hypotheses
The life stages most affected by degraded habitat conditions in these reaches are egg incubation, pre-spawning holding and fry colonization. These critical life stages are limited by degradation of the following habitat attributes:

- Habitat quantity (pool habitat areas) and quality (riparian function, LWD, and channel confinement)
- Channel stability (bed scour, riparian function, LWD)
- Sediment load (fine sediments)
- High and low flows.

By comparing the survival of Chinook life stages under existing conditions and fully restored habitat conditions, the EDT habitat model 'diagnoses' the potential of stream reaches for habitat restoration. The restoration potential of reaches in the Tier 1 subareas is shown in Figure 4-8. This potential results from instream habitats, basin-wide conditions that create and maintain that habitat, and Chinook use of habitat in the reach. For this reason the Technical Committee has used the watershed evaluation and EDT to prepare technical recommendations for the entire subarea as well as individual stream reaches. These recommendations are summarized in Table 4-15. The recommended changes to habitat attributes at the reach and basin scale are intended to create habitat conditions more favorable to critical Chinook life stages. The Technical Committee hypothesizes that improved conditions for these life stages will ultimately increase the productivity, spatial distribution, and life history diversity of the Issaquah Chinook population.

Table 4-15: Basin-Wide and Reach-Specific Restoration Recommendations for Issaquah Creek Tier 1 Subareas

Basin-Wide Restoration Hypotheses:

- Restore riparian vegetation to provide sources of LWD that can contribute to the creation of pool habitat.
- Egg incubation and fry colonization life stages would benefit from source control best management practices that reduce fine sediment inputs to the system.
- Egg incubation and fry colonization life stages would benefit from stormwater management practices that reduce sediment inputs from bed scouring high flows.
- Egg incubation and fry colonization life stages would benefit from riparian restoration to provide future sources of LWD that can improve channel stability and contribute to the creation of pool habitat areas with suitable cover.
- Fry colonization life stage would benefit from riparian restoration to reduce peak water temperatures that favor non-native species.
- Restoration of seasonal low flows would support the pre-spawning holding life stage in Issaquah Creek and the North and East Forks of Issaquah Creek.

- Fry colonization life stage would benefit from a review of hatchery outplant policies to ensure that predation on wild Chinook is minimized.

Reach-Level Restoration Hypothesis:

- Channel confinement has reduced floodplain connectivity and reduced the amount of pools and small cobbles. Reach-level restoration actions should focus on setback or removal of dikes and levees, the addition of LWD to create pools, and planting riparian vegetation.
- Fry colonization life stage would benefit from the addition of LWD to create pool habitat areas that reduce exposure to predators.
- Egg incubation life stage would benefit from the addition of LWD to create pool habitat areas that trap fine sediments. This recommendation does not address the causes of the sediment problem, and is intended to complement the source control and flow control measures identified as part of the basin-wide hypotheses.
- Restoration in the State Park reaches (1 and 2) should proceed cautiously to avoid adverse impacts to existing habitat.

These changes to habitat attributes at the reach and basin scale are intended to create habitat conditions more favorable to critical Chinook life stages. The Technical Committee hypothesizes that improved conditions for these life stages will ultimately increase the productivity, spatial distribution, and life history diversity of the Issaquah Chinook population.

Issaquah Chinook Tier 1 Migratory and Rearing Areas
Juvenile Chinook in the Issaquah system out-migrate through Lake Sammamish and the Sammamish River to Lake Washington, the Ship Canal, and the WRIA 8 nearshore. Restoration of each of these areas would benefit Issaquah Chinook, but the greatest restoration potential exists in Lake Sammamish, particularly in areas adjacent to the mouth of Issaquah Creek. Shoreline areas at the head of the Sammamish River in and around Marymoor Park have the next highest restoration potential within Lake Sammamish. Based on the EDT habitat modeling effort, it is hypothesized that juvenile migrants would benefit from actions that reduce predation and the efficiency of predator species such as cutthroat and residualized coho. The abundance and efficiency of predation appears to be driven primarily by conditions that limit cover for Chinook and increase exposure to predators, such as bank hardening, steep slopes, and a lack of LWD and shoreline vegetation. Restoration actions for Lake Sammamish are summarized in Table 4-16. Restoration actions for other migratory subareas used by Issaquah Chinook are covered in the NLW and Cedar River Chinook recommendations (Table 4-10). Although the Lake Sammamish shoreline is highly developed, the remaining areas with habitat characteristics likely to reduce predator abundance and efficiency (sandy shallow-water habitat, overhanging vegetation, LWD) should be protected and maintained.

Table 4-16: Restoration Recommendations for Issaquah Migratory and Rearing Areas

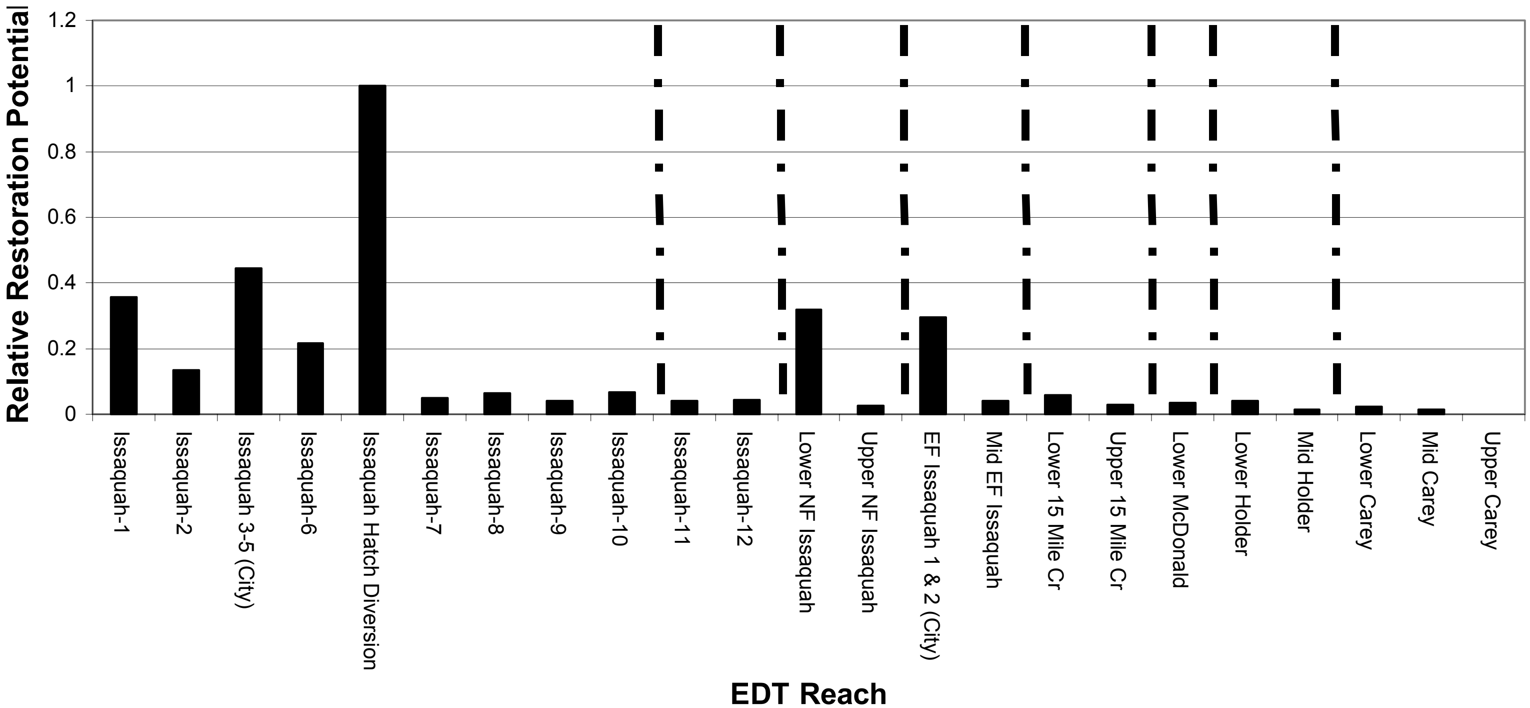
Lake Sammamish:

- Reduce bank hardening by replacing bulkheads and rip-rap with sandy beaches with gentle slopes designed to maximize littoral areas with a depth of less than 1 meter. The greatest restoration potential exists at the mouth of Issaquah Creek, followed by the head of the Sammamish River
- Reconnect and enhance small creek mouths as juvenile rearing areas. Historically these small creeks had sandy deltas at the creek mouth and were associated with wetland complexes. Protect and restore water quality in small tributaries.
- Juvenile Chinook in the NLW population are less shoreline-oriented than juveniles from the Cedar River. More information is needed about the trajectories of NLW juvenile Chinook in Lake Washington.
- The outmigration of juvenile Chinook would benefit from improved shoreline connectivity. The use of mesh dock surfaces and/or community docks would reduce the severity of predation on juvenile Chinook.
- Habitat in the smaller Lake Washington and Lake Sammamish tributaries (Tier 3 streams such as, but not limited to, Laughing Jacobs, Tibbetts, and Ebright Creeks) should be restored for coho so that production of cutthroat trout which prey on juvenile Chinook in Lake Washington is reduced.
- Consider increases in fishing limits for cutthroat trout.

Lake Washington, Sammamish River, Ship Canal, Ballard Locks, and Nearshore /Estuary:

See Table 4-10 NLW Chinook Recommendations

Figure 4-8: Issaquah Chinook Relative Restoration Potential



NOTE: The EDT habitat model determines the relative potential of a reach for salmon performance (a combination of productivity, abundance, and life history diversity) based on habitat conditions in the stream reach and the exposure of Chinook life stages to those habitat conditions. Similar habitat conditions may therefore result in different potentials due to differences in Chinook exposure. In addition, the salmon performance potential that exists in a reach may be due to upstream conditions (i.e. hydrologic conditions or sources of sediments and LWD) as well as conditions in the reach. For more information about habitat conditions, key life stages, and technical recommendations, please see the description of each subarea in the Conservation Strategy.

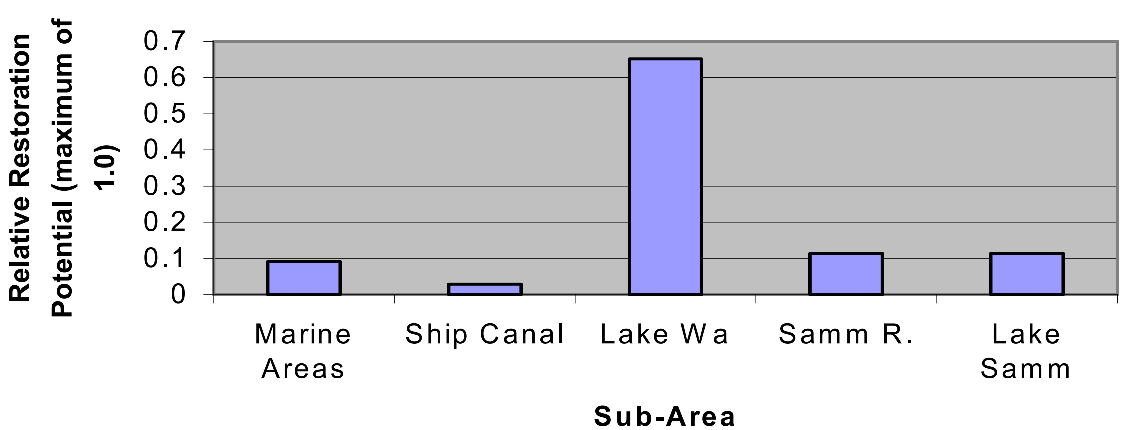
Comparing Areas Used by Multiple Populations

While this Conservation Strategy calls for habitat conservation actions to benefit each of the three WRIA 8 Chinook populations, the EDT diagnosis can be used to describe the relative potential of migratory and rearing areas that are used by multiple populations. While the impacts of specific actions are best evaluated as part of the Treatment phase of EDT, the geographic potential of these subareas can be used as guidance to help conservation planners target restoration actions. Actions in each of these migratory and rearing areas are necessary to create conditions that support population viability. However, the larger relative restoration potential of Cedar River Chinook (and greater uncertainties about modeling Chinook survival in the marine areas) results in greater weight being placed on restoration in Lake Washington. Lake Washington can be further sub-divided based on Chinook trajectories through the lake to provide a relative sense of where the greatest restoration potential exists in the Lake (Figure 4-9 and 4-10). This information is not intended to imply that conservation actions are only required in Lake Washington. Conservation actions are necessary in each of these subareas as different Chinook populations use them, and each area plays a unique role in supporting viability of WRIA 8 Chinook populations.

Conservation planners may also want to consider actions in migratory areas that benefit multiple populations. For examples, actions in the Ship Canal or in Union Bay would theoretically benefit all three populations, actions in the Sammamish River or the north end of Lake Washington would benefit two populations, and actions in the south end of Lake Washington would benefit one population. The Treatment phase of EDT (scheduled for completion in the fall of 2005) will provide conservation planners with a better understanding of the potential relative impacts of proposed actions, and it is anticipated that the impact of actions in the migratory areas benefiting multiple populations will be a central component of this analysis.

Specific recommendations for these subareas are discussed as part of the restoration recommendations for the Cedar, North Lake Washington, and Issaquah populations.

Figure 4-9: Relative Restoration Potential of Migratory and Rearing Areas



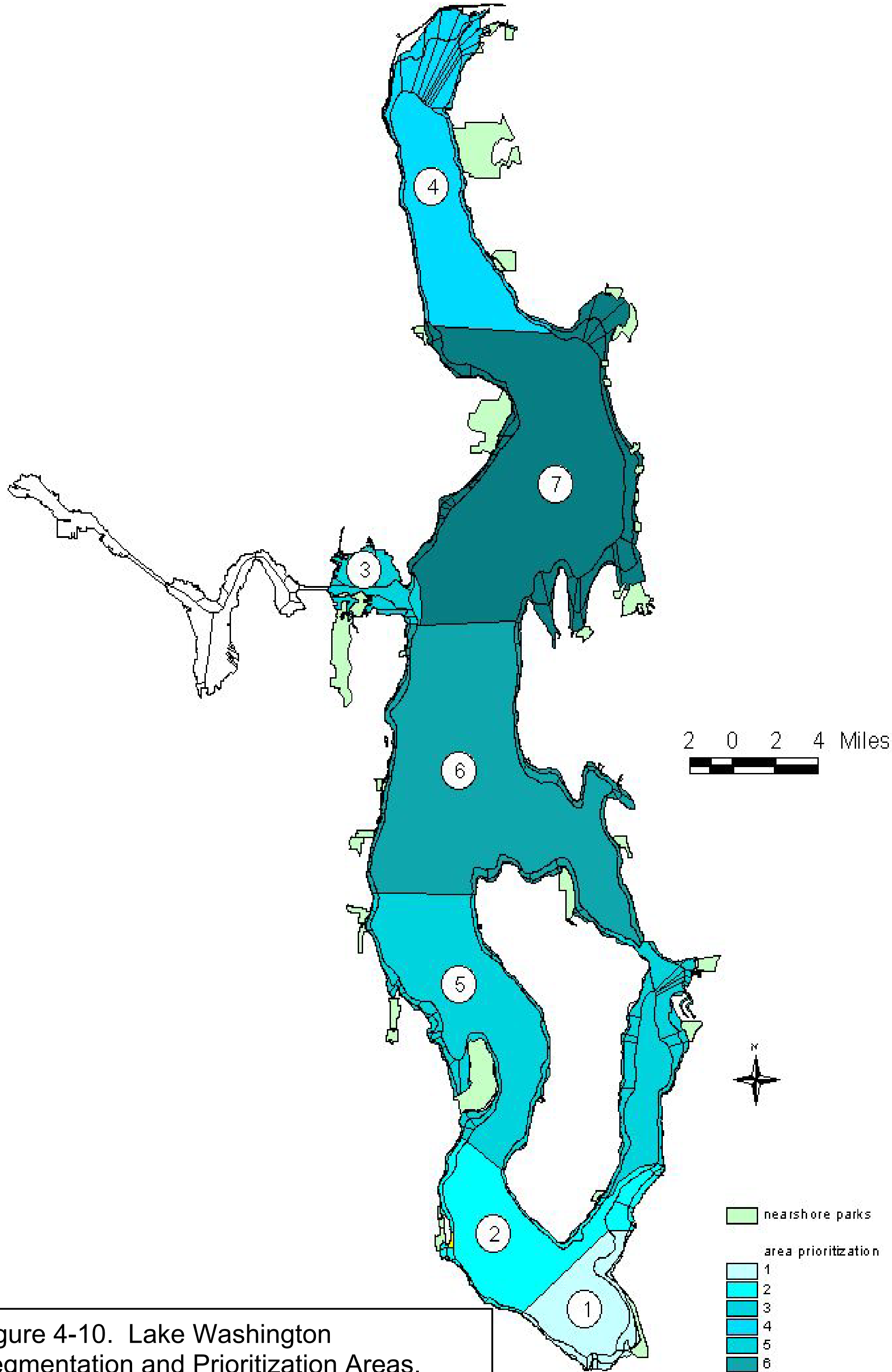


Figure 4-10. Lake Washington Segmentation and Prioritization Areas. For detailed description of lake 'reaches', please see Appendix C-4.

Potential WRIA 8 Habitat and Hatchery Scenarios: Implications of Alternative Population Structures for Chinook Conservation and Recovery in WRIA 8

As noted in Chapters 3 and 4, there is uncertainty regarding Chinook population structure in WRIA 8. The PSTRT has identified Cedar River Chinook and Sammamish River Chinook as two independent populations, with the Sammamish River population including North Lake Washington and Issaquah Creek sub-populations. In light of uncertainties about the relationship between North Lake Washington and Issaquah Chinook, the WRIA 8 Technical Committee decided to develop a Conservation Strategy for three populations (Cedar River, North Lake Washington, and Issaquah Chinook). This decision was based on the desire to adopt a conservative approach to WRIA 8 Chinook, and this approach errs on the side of caution to protect the habitat diversity that exists in WRIA 8.

In response to uncertainties about Chinook population structure, the WRIA 8 Technical Committee has initiated a genetic study with the Washington Department of Fish and Wildlife (WDFW) to analyze juvenile Chinook from the three assumed populations in WRIA 8, plus juveniles from hatcheries known to contribute to adult returns (e.g., University of Washington, Issaquah, Grover's Creek), as well as archived scale and tissue samples from adult spawners. It is expected that this study will help address a number of uncertainties surrounding current genetic differences that exist among wild and hatchery Chinook stocks in WRIA 8. This information will be reviewed by the WRIA 8 Technical Committee and other participating scientists, and shared with the PSTRT for their consideration in evaluating population structure in WRIA 8.

Any potential revisions to the basic population structure of WRIA 8 Chinook in response to this genetic analysis would have implications for WRIA 8's habitat strategy, as well as hatchery operation decisions by the tribal and state Co-Managers. The purpose of this section is to provide examples of some of these implications so that WRIA 8 is positioned to adapt the Conservation Strategy and proposed conservation actions in response to new information about Chinook population structure in WRIA 8. In discussing potential population scenarios and the implications of these scenarios for habitat conservation and hatchery management, several caveats must be kept in mind:

- Population structure decisions are not the purview of the WRIA 8 Technical Committee. The WRIA is providing information to the PSTRT and NOAA Fisheries, who are charged with identifying independent Chinook populations in Puget Sound.
- Hatchery management decisions are not the purview of the WRIA 8 Technical Committee, WRIA 8 Steering Committee or the WRIA 8 Forum. Hatchery management decisions are the jurisdiction of the Co-Managers (Treaty Tribes and the State of Washington).
- Implications of potential population scenarios for hatchery management were provided to the WRIA 8 Technical Committee by WDFW's liaison to the WRIA 8 salmon conservation planning effort, based on on-going discussions of the Co-Managers and the Hatchery Science Review Group (HSRG).
- Co-Manager decisions about hatchery management in response to the Hatchery Science Review Group (HSRG) recommendations are currently under discussion and are not final.
- The focus of this draft WRIA salmon conservation plan is habitat, as this is the area over which local parties have primary legal authority and responsibility. The WRIA 8 Steering Committee (1998) mission statement notes, however, that this "focus shall not keep the Steering Committee from encouraging appropriate reforms in harvest and hatchery

practices, the management of non-native species, and other activities outside of its direct control, which may be necessary for the successful conservation of salmon."

- The nested analytical approach that includes the Viable Salmonid Population Framework, Watershed Evaluation, and the Ecosystem Diagnosis and Treatment (EDT) Habitat Model was applied to the three Chinook population scenario. It has not been applied to other potential population scenarios, and detailed information about how the habitat strategy might change cannot be provided by the Technical Committee until this technical analysis is complete.
- As population scenarios change, the assessment of population status and relative risk to the viability of the population(s) is likely to change. However, given the long-term nature of Chinook recovery, it is unlikely that this change in relative risk will result in significant changes to high priority habitat conservation actions in WRIA 8 during the 10-year planning horizon.
- The WRIA 8 Technical Committee provides the scientific framework, based on NOAA Fisheries Viable Salmon Population (VSP) criteria, for identifying and prioritizing habitat restoration and protection needs to maintain independent Chinook populations. The Steering Committee is responsible for policy decisions and makes the final decisions on habitat actions and priorities that are included in the Plan.
- The implications of the Chinook population scenarios are provided as examples and are not intended to be an exhaustive list of all possible habitat and hatchery implications.

In addition to these caveats, the discussion of implications for hatchery management requires some definition of terms. The HSRG (2004) has provided several system-wide hatchery management recommendations designed to help ensure a scientifically defensible hatchery program. A key element of these recommendations is to manage hatcheries according to either an integrated or segregated strategy, based on the ecological context of each hatchery operation and the potential benefits and risks to naturally spawning salmon populations. These terms are defined as follows (WDFW, 2004 and HSRG, 2004):

- **Integrated Strategy.** The intent is for the natural environment to drive the adaptation of a composite population of fish that spawns both in a hatchery and in the wild. Habitat quality remains important if integrated artificial production programs are to be successfully implemented, as hatchery broodstock must include a percentage of natural-origin adults in order to maintain genetic characteristics of naturally spawning fish.

- **Segregated Strategy**. The intent is that reproductive isolation of returning adults from the hatchery program allows the natural environment to drive the adaptation of the natural population. Once established, segregated broodstocks are composed entirely of returning, hatchery-origin adults. As a consequence, genetically segregated hatchery populations can, and will, change genetically, relative to naturally spawning populations. Such changes may be intentional to maximize the desired benefits of the program, while minimizing risks to naturally spawning populations. However, in contrast to integrated programs, *any* natural spawning by hatchery-origin fish from a segregated program will impose potentially unacceptable risks to natural populations.

Regardless of the hatchery management strategy that is pursued, WDFW (2004) notes that productive, natural habitat provides the greatest certainty of healthy, harvestable salmon populations, and a 'balanced portfolio' of complementary habitat protection, habitat restoration, and artificial propagation will be necessary to recover sustainable, genetically diverse, harvestable populations of naturally-spawning Chinook salmon.

A matrix summarizing the following description of the potential implications of Chinook population scenarios on the WRIA 8 habitat strategy and Co-Manager decisions about hatchery management is included in Appendix C-5.

Scenario A: Three WRIA 8 Chinook Populations (Cedar River, North Lake Washington, and Issaquah

This is the assumed scenario for the Conservation Strategy described in this Chapter, and the basis for the conservation actions identified in Chapter 5. As described in the VSP assessment, the Cedar River Chinook population is presumed to be genetically independent, while the North Lake Washington and Issaquah populations are assumed to be closely related but with life history differences (e.g. run timing) and the potential for some genetically distinct characteristics. The Issaquah population is presumed to be heavily influenced by the hatchery.

This population scenario has the broadest ramifications for habitat actions, and requires the most comprehensive set of protection and restoration actions in order to return all three populations to viable levels. The habitat strategy differs for each of the three populations, with an initial focus on improving habitat productivity and life history diversity for the Cedar River Chinook population. In the North Lake Washington population, actions emphasize both productivity and spatial distribution (i.e., expansion of the population into North, Little Bear, Kelsey and Evans, as well as Bear/Cottage Creek). The distribution of this population is currently focused on the Bear/Cottage Creek system, while it is historically thought to have been distributed amongst multiple North Lake Washington tributaries. In order to reduce the overall risk posed to the viability of this population from this limited distribution, the population needs to expand into other North Lake Washington tributaries. Under this population scenario, Issaquah is the third priority for restoration actions, as the population is driven by hatchery production and therefore faces the lowest relative risk of extinction. Protection of functioning ecosystem processes and habitat function, however, are considered to be a high priority, as the Issaquah basin includes some of the best overall existing habitat in the WRIA.

The Issaquah hatchery is currently designated as a ‘segregated’ hatchery, with the objective of minimizing interactions between wild and hatchery Chinook (e.g., limit hatchery contribution to natural spawning to 1-5%, as suggested in the HSRG 2004 recommendation). In light of recent hatchery contribution rates (first able to be documented when ad-clipped hatchery origin adults returned in 2003) showing that 22% of spawners in the Cedar River were of hatchery origin, there is a risk that this high contribution of hatchery strays to naturally spawning populations may reduce the local adaptations and genetic diversity that are present in the Cedar and North Lake Washington populations. However, it is possible that current habitat productivity is so low that a reduction in hatchery contribution rates could reduce the total numbers of spawning adults and place the population at even higher risk of extinction. In order to meet HSRG goals for a low hatchery contribution rate while minimizing the risk of extinction for naturally spawning Chinook, significant habitat improvements will be necessary to increase natural production.

Scenario B: Two WRIA 8 Chinook Populations (Cedar River, Sammamish River)

This scenario is the population structure currently identified by the PSTRT. It includes a genetically independent Cedar River Chinook population (as in Scenario A) and a Sammamish River population that includes a naturally spawning hatchery influenced sub-population in North Lake Washington and a hatchery supported sub-population in Issaquah Creek.

Under this scenario it is possible that the WRIA 8 habitat strategy may narrow in focus. Emphasis on the Cedar River population would increase, as the Sammamish population may be at a relatively lower risk due to the hatchery support and the expansion of the population due to the inclusion of North Lake Washington and Issaquah Chinook. Compared to Scenario A, there is a relatively reduced emphasis on spatial distribution for the North Lake Washington portion of the Sammamish population. By combining North Lake Washington and Issaquah Chinook into one population, the overall spatial distribution of the population is no longer confined to one stream (Bear/Cottage Creeks), reducing the relative risk for this population viability attribute. However, habitat restoration in Bear/Cottage Creek, Issaquah Creek, and the Sammamish River might receive relatively greater emphasis in order to increase natural production overall and improve the fitness (or number of offspring produced) of natural spawners in Issaquah Creek. Efforts to increase the abundance of Issaquah Chinook would have to be monitored and balanced to avoid straying into the Cedar River until Cedar River Chinook abundance has been increased.

Either an integrated or segregated hatchery management strategy could be adopted by the Co-Managers under this population scenario. If an integrated strategy is selected, hatchery broodstock from each population would need to be managed separately from one another to maintain two genetically distinct populations.

Scenario C: One WRIA 8 Chinook Population

This population scenario assumes that naturally spawning Chinook in the Cedar River, North Lake Washington, and Issaquah Creek have all been heavily influenced by hatchery contributions over time and are therefore genetically similar.

In this scenario, habitat actions may narrow to target those areas that have the most potential to protect or restore habitat capacity and productivity throughout the WRIA. For example, protection actions could target existing core spawning areas in the Cedar River, Bear/Cottage Creeks, and Issaquah Creek, while restoration actions might focus on key migratory and rearing areas (such as the Ship Canal, Union Bay, and the Sammamish River) that benefit Chinook from more than one spawning area. As a result, habitat restoration actions might be less geographically diverse under this scenario.

An integrated hatchery management strategy is likely under this population scenario. In order to meet HSRG goals for a low stray contribution rate and increase the fitness of naturally spawning Chinook, significant habitat improvements to increase natural production would be necessary.

Goals and Objectives for WRIA 8 Habitat and Chinook Populations

Pursuant to the WRIA 8 Steering Committee mission statement, the WRIA 8 Steering Committee tasked the Technical Committee to identify habitat and population goals and objectives for WRIA 8's Chinook populations. The combination of habitat and biological goals recognizes that the activities of WRIA stakeholders (particularly local governments) most directly impact habitat conditions, but habitat conservation activities are intended to support the larger biological goal of recovering sustainable and harvestable populations of Chinook. Habitat goals and objectives are needed to understand how WRIA 8 can create habitat conditions that support Chinook viability; biological goals and objectives are needed to identify the characteristics of a viable population and the relative role of habitat in supporting that population.

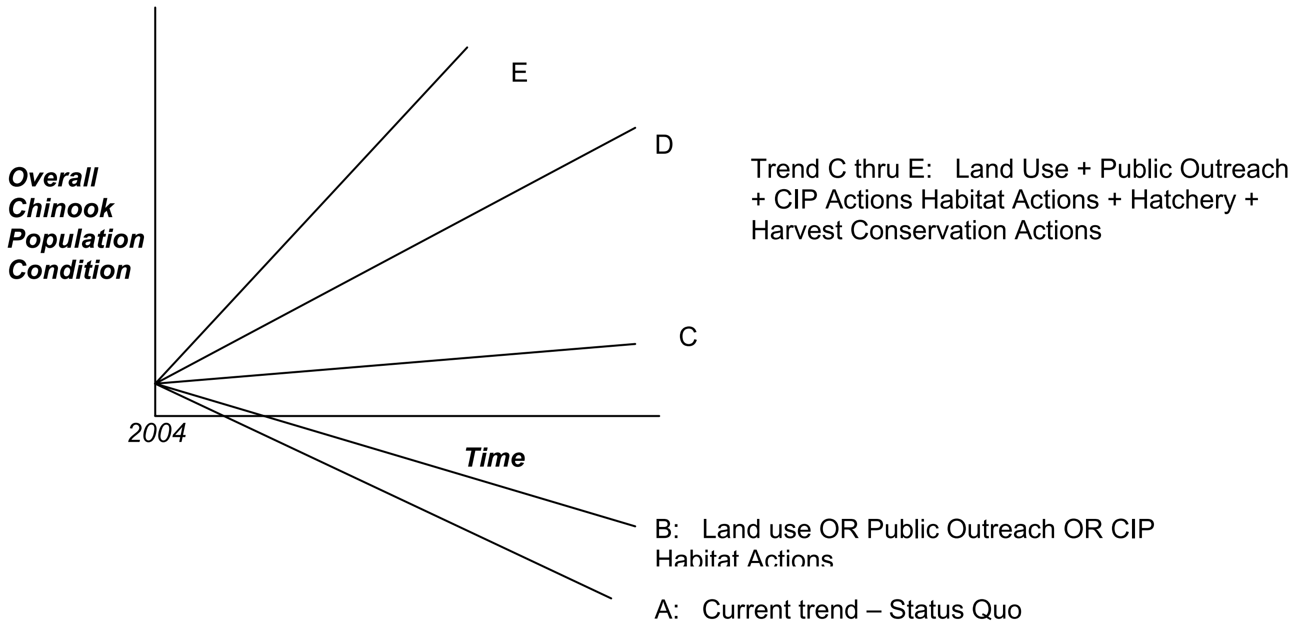
The state and Tribal Co-Managers have identified biological goals (referred to as 'planning targets') for most Chinook populations in the Puget Sound ESU. However, specific planning targets for independent populations in WRIAs 8, 9, and 10 were not provided while this Plan was in development. In the absence of planning targets for Chinook population attributes in these WRIAs, NOAA Fisheries has stated that their default objective for habitat (in the absence of locally generated objectives) will be Properly Functioning Conditions (PFC). In addition to PFC, the TRT has identified Population Viability Analysis (PVA) numbers for WRIAs 8, 9, and 10. These numbers have been established at 17,000 Chinook for each WRIA, which is the lower equilibrium spawner abundance values from PVA, assuming a population growth rate equal to 1. Immediately prior to the publication of this Plan in February 2005, the Washington Department of Fish and Wildlife (WDFW) provided recovery planning targets for WRIA 8. For the Cedar Chinook population, planning targets are 1,000-8,200 spawners with a productivity of 1-3.1 recruits/spawner. For the Sammamish population (combining NLW and Issaquah), the planning targets are 1,000-4,000 spawners with a productivity of 1.0-3.0. These numbers were generated by WDFW using the WRIA 8 Technical Committee EDT habitat model assuming PFC habitat conditions in rivers and streams and template (presumed historic) habitat conditions in the Lakes, Ship Canal, Locks, and estuary. Under template or historic conditions, the EDT model assumes the current hydrologic routing in WRIA 8, with the Cedar River flowing into Lake Washington and connection to Puget Sound through the Ship Canal and Locks.

The Technical Committee found it most useful to think about habitat and population goals and objectives in terms of overall trends rather than focusing narrowly on absolute numbers. This is largely due to the fact that salmon populations are naturally highly variable and an excessive focus on maintaining one value for productivity and abundance would result in highly unstable and unviable populations. Any short-term objectives and long-term goals discussed in this section should be considered within the context of a larger goal of restoring naturally dynamic population structures.

Most importantly, the Technical Committee focused on overall trends due to the simple fact that WRIA 8 Chinook populations are in decline and the productivity of these populations must increase if extinction is to be avoided. As noted in the Viable Salmonid Population Framework (Appendix C-1), the short-term and long-term productivity of the Cedar River Chinook population is below 1 (0.933-0.966), meaning that spawners are not replacing themselves. If this range of productivity continues, abundance would drop below theoretical minimum viable population thresholds (assumed to be 100-250 spawners, based on McElhany et al 2000) in 12-50 years. In the NLW population, productivity was estimated to be between 0.995 and 1.077. In both populations current low abundance levels raise serious concerns about the potential risk of extinction from environmental disturbances, demographic stochasticity, or inbreeding depression. <u>Regardless of long-term abundance objectives, habitat actions to increase productivity trends above 1 are necessary to avoid extinction in the near term and restore WRIA 8 Chinook to viability in the long-term.</u>

In discussing potential approaches to habitat and biological goals and objectives, the Technical Committee used the simple graphic shown in Figure 4-11 to describe hypothetical Chinook population conditions and trends. Under current conditions, WRIA 8 populations are believed to be on a path toward extinction (Trend A), while uncoordinated individual habitat actions (Trend B) only serve to slow rather than reverse this trend. Trends C through E represent potential trajectories from varying intensities of coordinated habitat, hatchery, and harvest actions.

Figure 4-11: Hypothetical Chinook Population Trends



Given the low population numbers and downward trends of WRIA 8 Chinook populations, there is a high potential that population effects (Allee effects) may drive the population to extinction if habitat, hatchery, and harvest conservation actions are not implemented. Under these conditions the pace of recovery (as represented by the slope of the line) should be more similar to Trend E than Trend C. The figure does not identify thresholds for Chinook recovery such as viability, ESA de-listing, sustainability, or harvestability. In addition, the simplistic representation of overall population condition is not intended to imply that population recovery can or should occur at a constant pace over time. The Technical Committee is less concerned with precisely defining viability for the WRIA 8 populations, and more concerned with reversing the current downward trend before the populations are extinct. Put simply, the Technical Committee believes there is a negligible risk of overshooting population viability goals within the plan timeline of 10 years, while the risk of extinction under current trends is extremely high. However, the Technical Committee recognizes that long-term goals are necessary as context for short-term objectives and for measuring progress toward recovery. The Technical Committee will be evaluating the planning targets identified by WDFW along with other potential performance measures described in this Chapter as part of the evaluation of conservation actions during 2005.

Recognizing that Chinook populations are naturally variable and that the current negative population trends need to be reversed quickly, the Technical Committee has identified potential habitat and population goals for the near-term (10 year plan horizon) as well as the long-term goal of creating habitat conditions that support viable populations of Chinook salmon (summarized in Table 4-16). The Technical Committee has not finished the discussion on objectives for some attributes. The concept for the goal has been identified, even if the objective has not been established. In some cases the Technical Committee proposes a number of possibilities for further evaluation.

The Technical Committee discussion of habitat goals and objectives has focused on variations of PFC. Possibilities under consideration include a percentage of PFC, similar to the habitat recovery objectives identified by WRIA 7 (Snohomish County, 2004) or a modified PFC for urban areas (such as that described in NOAA Fisheries 2003 or a percentage improvement in key habitat attributes identified through the EDT model and the WRIA 8 limiting factors report. Habitat objectives have not been finally determined and will be evaluated by the Technical Committee using the EDT model to compare the relative impact of these objectives on Chinook performance. As noted in Chapter 6, short-term habitat objectives will need to reflect the fact that some habitat actions may not be seen within the 10-year plan horizon. Examples of response times for typical habitat restoration actions are shown in Beechie et al, 2003 and range from 1-5 years for most instream habitat projects to greater than 10-50 years or more for some land use actions.

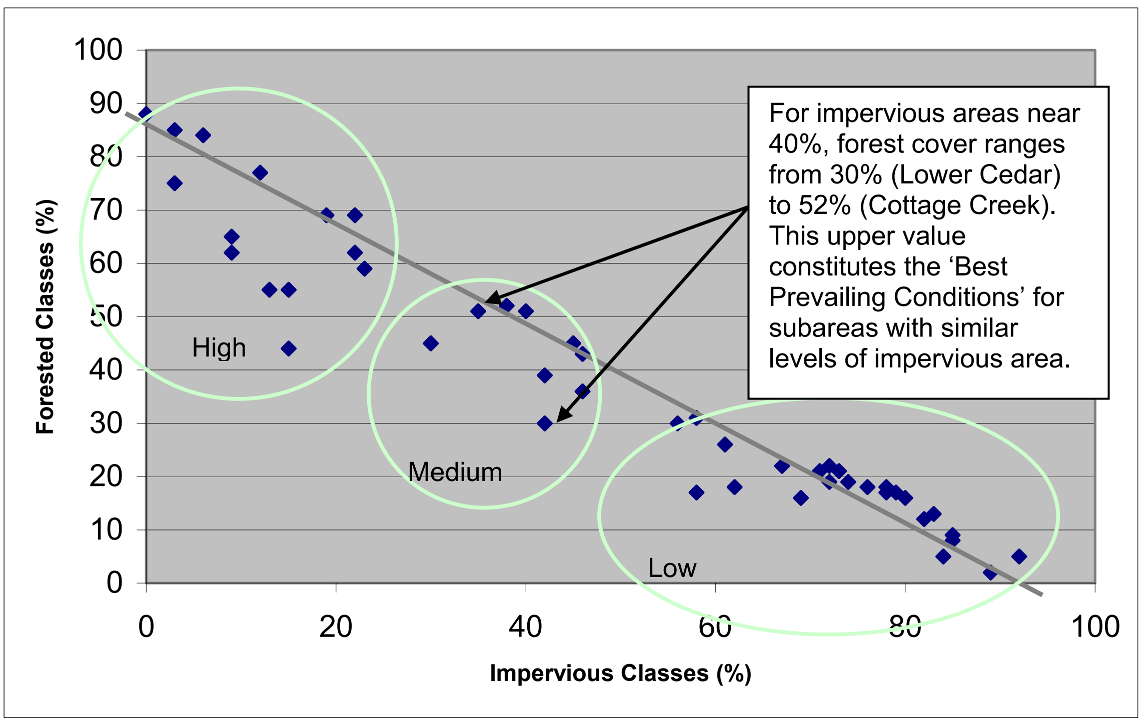
As part of the Technical Committee's evaluation of potential habitat objectives, LWD performance standards from various authors (Fox 2001, May 1996, and WFPB 1997) were applied to reaches identified in EDT as having a high restoration potential. For Bear Creek EDT reach 10 (0.69 km), approximately 170 pieces of LWD (>2 m length, >10 cm diam) would need to be placed to meet Best Prevailing Conditions (380 pieces/km) in WRIA 8 sub-areas with similar levels of impervious surface, and WSFB conditions of 2 pieces per channel width. Among these 170 pieces, 75 pieces should/could be "key" pieces meeting WFPB definition of "key pieces," 2.5 m3. In terms of an actual restoration project or approach, a focus on placing only "key" pieces might be advisable given the short- and longer-term potential for the Bear Creek and Cottage Lake Creek buffers to supply smaller woody debris. As part of the Treatment phase of EDT it is anticipated that the EDT model could be used to compare the relative effectiveness of meeting PFC in higher priority reaches versus supplying lower densities of wood ('key pieces') in more stream reaches throughout the system.

Table 4-17: WRIA 8 Goals and Objectives for Habitat and Chinook Populations

	Near-Term (10-yr) Objective	Long-Term Goal	Comments
Habitat – Instream	• Percentage of PFC (see, for example, WRIA 7) • Percentage increase in current conditions	PFC	• In the highly urbanized sub-basins of WRIA 8 PFC may not be possible. Near-term objectives may vary by subarea • PFC not developed for lakes, modified estuary, nearshore
	Percentage of modified PFC	Modified PFC	See, for example, Clark County and NOAA Stormwater Guidance for modified PFC in urban areas
Habitat – Landscape Conditions	• Percentage of PFC • Best Prevailing Conditions	PFC or Modified PFC	
Biological - Chinook Populations	See below	Viability (less than 5% risk of extinction over 100 years)	See individual population attributes below
Productivity	• 2X current survival for juveniles and smolts within subareas • ≥2 adult returns/ spawner 2-4 years out of 10	≥1 adult returns / spawner X years out of Y WDFW target: 1-3.1 recruits/spawner in Cedar, 1-3 recruits/spawner in Sammamish	While productivity greater than 1 indicates a growing population, the low current population numbers may require an initially higher productivity to reduce the risk of adverse impacts from Allee effects, environmental perturbations, and natural population fluctuations
Spatial Structure	Convert 1 satellite subarea to core (i.e. Upper Cedar and North Creek); expand spawning area distribution	• Recapture historic distribution; • Consistent use of NLW tribs in addition to Bear for spawning)	Historic Chinook distribution is assumed to be with current hydrologic routing in WRIA 8 (that is, no reconnection of the Cedar River to the Duwamish River and the WRIA 9 Chinook population)
Life History Diversity	Percentage increase in Cedar instream rearing trajectory; improve Sammamish habitat conditions to support eventual smolt rearing	Increase Cedar instream rearing trajectories from 25% to 50% (the presumed historic percentage); Increase % of smolts rearing in the Sammamish River	Changes in juvenile life history trajectories monitored through smolt traps and PIT tags
Abundance	Meet co-manager escapement goals of 1,250 naturally spawning adults on Cedar and 350 in Bear & Cottage Lake Creeks	• WDFW Target: 1,000-8,200 spawners in Cedar; 1,000-4,000 spawners in Sammamish • Use EDT "Margins of Sustainability" to estimate minimum sustainable populations	Escapement is a co-manager objective that reflects management as well as biological needs. However, meeting escapement goals would represent a significant increase for WRIA 8 populations.

Some landscape factors included in the watershed evaluation have PFC criteria, but the Technical Committee is considering the use of the watershed evaluation analysis to identify 'Best Prevailing Conditions'. As shown in Figure 4-12 below, when landscape factors such as forest cover can be compared to impervious surface there is considerable variation for a given level of impervious surface. In Figure 4-12 this can be interpreted to mean that when impervious surface levels are at 40%, forest cover can be as high as 52% based on current WRIA 8 conditions. In areas with 10-15% impervious area, forest cover varies considerably from 45% (Peterson Creek) to nearly 80% (East Fork Issaquah). The upper values in the forest cover range could be said to constitute 'Best Prevailing Conditions", and could be used as an objective for other subareas with similar levels of impervious surface. This concept could also be expanded to in-stream habitat conditions evaluated in the EDT model. The Technical Committee recognizes that this objective is based on current conditions in WRIA 8 rather than what is biologically necessary to support viability. However, it may represent a practical starting point for increasing landscape factors such as forest, wetland, and riparian cover, as well as in-stream habitat conditions such as woody debris, channel connectivity, and water quality.

Figure 4-12: Example of 'Best Prevailing Conditions' Line for Forest Cover under Varying Levels of Impervious Area



Chinook population goals and objectives are based on the analysis of population status contained in the VSP Framework. While the EDT habitat model includes productivity, abundance, and diversity outputs, these numbers are appropriately used for making relative comparisons and the absolute value of the model outputs have limited utility as planning targets for Chinook populations. Biological objectives are based on moving population attributes in the direction of presumed historic status for the population.

For both the Cedar and NLW Chinook populations increased productivity is the primary objective if current population trends are to be reversed. While the number of adult returns per spawner must exceed 1.0 for the population to be growing, the Technical Committee believes that higher changes in productivity are necessary in the face of extremely low population numbers. The Technical Committee recommends that juvenile survival (not overall productivity) within WRIA 8 subareas be doubled within the plan horizon of 10 years. This means, for example, doubling survival of juveniles within subareas, as measured by the number of fry produced on the spawning grounds, the number of fry and/or smolts migrating from the spawning grounds, and the number of juveniles in the Sammamish River, Lake Washington, the Ship Canal (including the Ballard Locks), and the nearshore subareas.

For spatial distribution, the Technical Committee has established a long-term goal of re-establishing the historic distribution of each population, with a near-term objective of converting a satellite area into a core area with relative high abundance and consistent use by spawning Chinook. In the Cedar River, the Upper Cedar (above Landsburg Dam) is a prime candidate for increased use by spawners if we are to extend the longitudinal distribution of spawning along the mainstem Cedar. In the long term, other satellite areas should also become core areas of production to minimize risk to the population. For the NLW population the long-term objective is to support frequent and relatively proportional spawning in each of the tributary areas (Bear, Evans, Little Bear, North, and Kelsey). In the near term the Technical Committee has not identified a specific tributary to target for increased spawning. Rather, it is hypothesized that restoration of North and Little Bear Creeks, along with restoration of the Sammamish River corridor will result in increased Chinook use of the Tier 2 sub-areas. Little Bear has some of the best remaining habitat of the north Sammamish River tributaries, while North Creek is most likely to support sustained Chinook use given its size and habitat capacity (Sanderson et al 2003).

For life history diversity, the Technical Committee has established a goal of increasing the Cedar River instream rearing life-history trajectory from 25% to 50% of out-migrants. A near-term objective for the 10-year plan horizon has not been established, but is likely to be a percentage increase (25-50%) over the current level. This would mean an interim objective of 30-40% instream rearing by juvenile Chinook. In the NLW population, the objective is to increase the percentage of Sammamish River rearing life history trajectories. Specific goals and objectives have not been established by the Technical Committee.

As noted earlier in this section, this Plan was developed without specific abundance planning targets from the Co-Managers. In February 2005 WDFW established planning targets of 1,000-8,200 spawners in the Cedar River population and 1,000-4,000 spawners in the Sammamish population. In order to identify performance measures for WRIA 8's adaptive management program, the Technical Committee will continue to evaluate potential long-term abundance objectives such as those provided by WDFW in order to better understand the population levels necessary to first avoid extinction and then reach WRIA 8's objective of providing habitat conditions that support sustainable and harvestable Chinook populations. This evaluation of potential performance measures will continue as part of the Technical Committee's evaluation of action effectiveness using the EDT model and other analyses during 2005. The Technical Committee will evaluate multiple lines of evidence along with the WDFW planning targets, including the following:

- NOAA Fisheries Spawning Capacity Analysis (Sanderson et al 2003): estimate of density-independent habitat capacity based on an analysis of several landscape factors.
- EDT Template (WRIA 8, 2003): Estimate of density-independent habitat capacity based on assumed historic habitat conditions and current hydrologic routing.
- EDT 'Margins of Sustainability' in the EDT model: estimate of self-sustaining population sizes based on professional judgment using EDT population performance curves
- Population Viability Analysis: evaluates extinction risk under different timeframes. Assumes that future population productivity can be estimated based on historic observed abundance levels. Does not factor in density-dependent effects such as increased competition as population size increases.
- Theoretical values from the conservation literature (for example 1,000-5,500 spawners cited in McElhany et al 2000 necessary to avoid deleterious effects from genetic drift and environmental stochasticity)

Until this analysis is completed, the Technical Committee has identified existing Co-Manager escapement objectives as the abundance objective for the 10-year plan horizon. While these objectives (1,250 spawners in the Cedar and 350 spawners in the NLW tributaries) would constitute a considerable improvement from current levels for WRIA 8's Chinook populations, it is important to note that these fisheries management objectives do not necessarily equate to viability.

Regardless of the total abundance, the number of local spawning aggregations should also be increased along with the number of returning adults. In the case of the Cedar River population this means extending the spawning distribution above Landsburg Dam, as well as increasing the density of spawning below Landsburg. For the NLW Chinook population, this expansion of spawning aggregations should be achieved through expansion into satellite areas rather than expanded distribution within the Bear and Cottage Lake Creek system, which are presently thought to be at or near capacity.

The Technical Committee has not established population goals for naturally spawning Chinook in the Issaquah Basin. Population attributes are strongly driven by hatchery operations and the likelihood of a persistent Chinook population in the Issaquah basin in the absence of the Issaquah Hatchery is uncertain, as Issaquah Creek was not likely used by Chinook prior to the establishment of the hatchery. While habitat protection and restoration hypotheses have been developed for the Issaquah basin, naturally-spawning Green-River origin Chinook are considered a potential source of risk to the genetic integrity of the Cedar and NLW populations. Inclusion of the Issaquah population in the development of biological goals and objectives will be re-evaluated pending the results of genetic analyses by the WDFW genetics lab in February 2005.

The Technical Committee has not set goals or objectives related to hatcheries, as the operation of hatcheries is the under the Co-Managers jurisdiction and outside the jurisdictional authority of the WRIA planning effort. However, based on preliminary information about the contribution rates of hatchery fish on the WRIA 8 spawning grounds, the Technical Committee strongly and unequivocally supports the recommendations of the Hatchery Science Review Group (HSRG, 2004) concerning the operation of the Issaquah Creek Hatchery by the Co-Managers and the implementation of the Hatchery Genetic Management Plans to ensure that the genetic integrity of WRIA 8 populations are maintained. Where there is uncertainty about the impacts of hatchery-wild interactions, hatchery management actions should err on the side of conserving viable populations of Chinook. The Technical Committee is currently working with the WDFW genetics lab to increase our understanding of the level of genetic diversity that exists in WRIA 8, and additional work will be necessary to better understand the effects of hatchery straying on the genetic diversity of WRIA 8 populations.

For a description of WRIA 8's approach to monitoring and evaluating progress toward habitat and biological goals, please see Chapter 6.

Summary of the WRIA 8 Conservation Strategy

The Puget Sound Technical Review Team (PSTRT, 2001) has identified two independent populations of Chinook in WRIA 8: the Cedar River and Sammamish River Chinook. The Sammamish River population includes North Lake Washington and Issaquah sub-populations. In their determination of population structure, the PSTRT notes that it is unclear whether the tributaries draining into the north end of Lake Washington historically supported an independent Chinook population. However, the PSTRT has also identified two factors indicating that this area has the potential to support independent Chinook populations. First, the PSTRT states that the Sammamish River drainage (including Issaquah Creek and the North Lake Washington Tributaries) is larger than the smallest watershed containing an independent population in their analysis of Puget Sound Chinook populations. Second, a recent analysis of spawner capacity developed for the PSTRT by NOAA Fisheries (NOAA Fisheries 2003) indicates that the Bear/Cottage system, the lower portion of North Creek, and Issaquah Creek have a high probability of supporting Chinook spawning, while Swamp Creek, Little Bear Creek, Carey and Holder Creeks, and the upper portion of North Creek have a moderate probability of supporting Chinook spawning.

While two populations are identified in WRIA 8 by the PSTRT, recent genetic information available at the time the Conservation Strategy was developed indicated that there may be enough difference between the North Lake Washington Chinook and fish returning to the Issaquah Creek Hatchery to consider them separate from one another (Marshall 2000). In addition there are other differences such as run timing (e.g., the North Lake Washington Chinook run starts earlier than Issaquah Hatchery returns, peaks at approximately the same time, and tails off over a longer period) that may reflect genetic differences between North Lake Washington and Issaquah Chinook that should be maintained.

After much discussion, the WRIA 8 Technical Committee decided to take a precautionary approach and plan for three populations: the Cedar River population, the North Lake Washington population, and the Issaquah population. The Technical Committee recognizes that the Issaquah and North Lake Washington populations are closely linked, with the Issaquah Hatchery population influencing the North Lake Washington population. The W8TC based their decision to plan for three populations on the desire to adopt a conservative approach to WRIA 8 Chinook populations in light of uncertainties about population structure, and the potential that unique genetic characteristics necessary for the long-term viability of the Issaquah and North Lake Washington populations, if lost, may not be recovered. By identifying three populations, the WRIA placed priority on protecting all Chinook within the watershed, as well as any local adaptations that these fish possess. This approach supports the continued survival of offspring of naturally spawning Issaquah Hatchery Chinook strays which would be protected under the Endangered Species Act. In addition, the three population approach errs on the side of caution to maintain future opportunities for conservation in the Issaquah sub-area. Finally, this approach confers ancillary benefits on other species such as coho, and supports the widest level of stakeholder participation, all of which are consistent with the Steering Committee's stated goals and objectives. Throughout this document, three populations will be discussed, consistent with the direction that WRIA 8 chose to take with Chinook recovery. <u>The reader should note that the use of the term 'population' as it relates to Chinook throughout this document reflects the WRIA 8 Technical Committee's precautionary approach, and that the term is therefore NOT synonymous with the PSTRT's use of the term</u>.

The discussions surrounding WRIA 8 population structure are continuing as new information materializes. In 2003, returning adult hatchery Chinook were adipose-clipped for the first time. Stray rates in that year indicated that there were more hatchery-origin fish on the spawning grounds than expected (22% of spawners in the Cedar River mainstem, 54% of spawners in Bear/Cottage Creeks, and 48% of all spawners in the WRIA). While straying is a natural phenomenon, the large releases of hatchery fish (e.g. 2 million Chinook fry are released annually from the Issaquah hatchery) combined with small populations of naturally-spawning Chinook in WRIA 8 (average adult returns to the Cedar River, for example, was only 325 fish between 1998 and 2002) mean that the relatively high contribution rates of hatchery-origin fish could pose a risk to the genetic diversity of the Cedar and North Lake Washington populations.

The WRIA 8 Technical Committee has initiated a genetic study with Washington Department of Fish and Wildlife (WDFW) to analyze juvenile samples taken from the three assumed populations in WRIA 8, samples from hatcheries known to contribute to adult returns (e.g., University of Washington, Issaquah, Grover's Creek), as well as archived scale and tissue samples from adult spawners. It is expected that this study will help address a number of uncertainties surrounding current genetic differences that exist among wild and hatchery Chinook stocks in WRIA 8. However, it is likely that there will be continued questions regarding the interactions of hatchery and wild Chinook. The WRIA 8 Technical Committee and participating scientists will review the genetic study and share the information to the PSTRT for consideration in identifying independent populations within WRIA 8. If necessary, the Technical Committee will then adapt the Conservation Strategy in light of this new information.

<u>The current risk of extinction posed to the WRIA 8 Chinook populations is extreme and must be reduced through actions that create habitat conditions that support viability of each population.</u> There is some uncertainty that the NLW and Issaquah populations are independent of one another. Based on this uncertainty and the declining productivity trend of the Cedar population, the Technical Committee hypothesizes that a relatively higher priority should be placed on risk reduction for the Cedar River Chinook population.

Cedar River Chinook

The greatest source of risk comes from reduction in habitat productivity and the potential loss of the instream juvenile rearing life history strategy. In addition, hatchery influences pose a significant risk to the genetic diversity of the population. Rehabilitation of the Cedar River Chinook population requires conservation actions to protect and restore habitat in the Tier 1, Tier 2, and migratory subareas. The main source of productivity for this population is in the Tier 1 subareas along the mainstem of the Cedar River. Restoration of these subareas is important to increase productivity and create habitat conditions that support the instream juvenile rearing life history strategy. Hypotheses about conservation actions are focused on the protection of water quality and high-quality instream habitats used for spawning and juvenile rearing, such as intact pool habitats, riparian buffers, and LWD. Restoration hypotheses are focused on increasing the availability of pool habitats and off-channel areas for juvenile Chinook by re-connecting floodplain areas, adding LWD, and re-planting riparian vegetation. In addition to restoration actions in the mainstem Cedar, juvenile Chinook would benefit from shoreline restoration actions designed to improve rearing and refuge habitat and reduce predator efficiency in the south end of Lake Washington and in the Ship Canal.

Shoreline restoration activities should focus on removal of bulkheads and rip-rap to create sandy, shallow habitat areas. These restoration actions should be focused on areas adjacent to the mouth of the Cedar River and in nearby areas of southern Lake Washington, along the south end of Mercer Island, at the mouths of small creeks, and in Union Bay.

North Lake Washington Chinook

The low abundance of the NLW Chinook population results from reduced habitat productivity and severe reduction in the spatial distribution of the population from several streams systems with approximately equal contribution to the population (Bear, Little Bear, North, and Kelsey Creeks) to one stream system (Bear Creek) that is the core of the population. In addition, hatchery influences pose a significant risk to the genetic diversity of the population. In order to rehabilitate this population and reduce the risks of extinction, conservation actions should be targeted at protecting the existing source of productivity in the Bear Creek system, restoring the habitat capacity of the Tier 2 NLW tributary systems, and restoring the channel meanders and pool habitats that support juvenile rearing and adult migration in the Sammamish River corridor.

Issaquah Creek Chinook

The Technical Committee is concerned about the risk to independent Chinook populations posed by straying of hatchery and naturally-produced hatchery-origin Chinook. In 2003, approximately 50% of spawners in WRIA 8 were hatchery-origin fish, with percentages as high as 75% in some stream systems. Based on this data and past genetic analyses of NLW and Issaquah Chinook, the Technical Committee calls on NOAA fisheries and the co-managers to implement the recommendations of the Hatchery Science Review Group (HSRG, 2004) and make any other appropriate management changes at the Issaquah and other Puget Sound hatcheries that are necessary to reduce risk to the Chinook populations in WRIA 8. Within the Issaquah system, conservation actions for the Issaquah Chinook population should focus on protection of existing high-quality habitat in the Issaquah system.

Although restoration hypotheses have been identified by the Technical Committee, restoration actions for Chinook should not proceed until NOAA Fisheries has concluded the status of the WRIA 8 populations. Based on current information about the genetics and stray rates of Issaquah-origin Chinook, the Technical Committee hypothesizes that restoration of habitat in the Issaquah system and Lake Sammamish could increase the already high spawning contributions from hatchery strays in the WRIA and thereby increase the risk to genetic diversity of the Cedar and NLW independent Chinook populations.

Migratory and Rearing Areas

In order to create and maintain habitat conditions that support viable populations of Chinook, conservation actions should address habitats used at different stages of the Chinook life cycle. Restoration and enhancement of the migratory and rearing areas (including the nearshore, estuary, Lake Washington, the Ship Canal and Locks, the Sammamish River, and Lake Sammamish) have a high potential to benefit Chinook productivity and abundance, and in many cases could benefit multiple populations. In the lakes, actions should focus on creating habitat conditions that improve rearing and refuge opportunities, such as the restoration of sandy shallow water areas and restoration of stream deltas. In the Sammamish River, re-meandering of the river will restore connections with cool groundwater while increasing habitat diversity, benefiting juvenile out-migrants as well as returning adults. High temperatures in the Ship Canal during the juvenile out-migration can become extremely stressful (>19 C) and affect the behavior and success of smolts in reaching Puget Sound. High temperatures may also affect predation rates in the Ship Canal, especially those of bass. Conservation actions should focus on providing habitat refuge for Chinook and reducing high temperatures that drive predation. Finally, the nearshore and estuary subareas are critical for migration and rearing of Chinook populations (as well as other species) from multiple WRIAs. While there are relatively greater uncertainties about nearshore habitat and Chinook use of that habitat, experimental approaches to the protection of functioning habitat and the restoration of ecosystem processes (particularly sediment supply) and habitats (particularly eelgrass beds and 'pocket' estuaries) should be implemented.

Uncertainties Regarding Hatchery Contribution to Natural Spawning of Chinook

In 2003, returning adult hatchery Chinook were adipose-clipped for the first time. Stray rates in that year indicated that there were more hatchery-origin fish on the spawning grounds than expected (48% on average in WRIA 8, 22% in the Cedar River, 54% in Bear Creek). While this represents only one year of data and the genetic impacts of this level of straying and spawning contribution from decades of hatchery operations are not known, the Technical Committee has taken a precautionary approach and identified hatchery straying and the potential contribution to natural spawning as a significant risk to the genetic diversity of WRIA 8 Chinook. The Technical Committee, in cooperation with WDFW, has initiated an analysis to evaluate the genetic differences between WRIA 8 populations and nearby hatchery stocks, and a report is expected in February 2005. Additional studies will be needed to evaluate the following questions:

- How much of a contribution do hatchery strays make to the genetic pool in the Cedar and NLW tributaries?
- How does straying affect the local adaptation of the Cedar and NLW groups (e.g., what is the reproductive success of hatchery strays)?
- How does hatchery straying affect population dynamics/persistence given low returns?

References

Beechie, T.J., E.A. Steel, P. Roni, and E. Quimby (editors). 2003. Ecosystem recovery planning for listed salmon: an integrated assessment approach for salmon habitat. US Dept of Commerce, NOAA Tech Memo. NMFS-NWFSC-58, 183 p. Available at: http://www.nwfsc.noaa.gov/publications/techmemos/tm58/tm58.pdf

Bolton, S. and J. Shellberg. 2001. Ecological issues in floodplains and riparian corridors. White paper prepared for Washington Department of Fish and Wildlife, Washington Department of Ecology and Washington Department of Transportation. University of Washington, Center for Streamside Studies.

King County, 2004. Best Available Science Volume 1: A Review of Science Literature. Available at: http://www.metrokc.gov/ddes/cao/.

Lakey, Kirk (Washington Department of Fish and Wildlife). October 12, 2004. Personal Communication.

Martin, D. 1999. An Ecosystem Strategy For Restoring Threatened/Endangered Salmon In King County. Prepared by Martin Environmental for King County, Washington.

May, CW. 1996. Assessment of cumulative effects of urbanization on small streams in the Puget Sound lowland ecoregion: Implications for salmonid resource management. Doctoral dissertation. University of Washington, Seattle WA.

McElhany, P., M. Ruckelshaus, M. Ford, T. Wainwright and E. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U. S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-42, 156 p.

NOAA 2003. HCD Stormwater Online Guidance ESA Guidance for Analyzing Stormwater Effects. Habitat Conservation Division. NOAA-Fisheries Northwest Region. March 2003.

Sanderson, B., J. Davies, K. Lagueux, T. Beechie, M. Ruckelshaus, and W. Holden. 2003. WRIA 08 DRAFT SUMMARY REPORT: An Assessment of Chinook Spawning Potential in the Cedar-Sammamish Watershed Resource Inventory Area. Prepared by The Puget Sound Chinook Recovery Analysis Team. Prepared for the Puget Sound Chinook Technical Recovery Team and the WRIA 08 Watershed Group.

Snohomish County. 2004. Draft Snohomish Basin Salmon Conservation Plan. Available at: http://www.co.snohomish.wa.us/publicwk/swm/Publications/2004DraftSnohoBasinSalmoConservationPlan/index.htm

Spence, B. C., G.A. Lomnicky, R.M. Hughes, and R.P. Novitzki. 1996. *An Ecosystem Approach to Salmonid Conservation.* TR-4501-96-6057. ManTech Environmental Research Services Corp., Corvallis, Oregon.

Washington State Forest Practices Board (WFPB). 1997. Watershed Analysis Manual, v. 4.0.

WDFW. 2004. Role of Hatcheries in Salmon Recovery: Concepts and Tools. Presentation by WDFW Director Jeff Koenings to September 23, 2004 meeting of the Shared Strategy Development Committee.

WRIA 8 Steering Committee. 1998. Mission, Goals, Requirements, and Approach. Available at: http://dnr.metrokc.gov/Wrias/8/wria8mission.htm